THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

GAME BIRDS

1 Snipe [illegible] Wild Duck [illegible]

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

BY THE MOST DISTINGUISHED AUTHORITIES AND SPECIALISTS UNDER THE EDITORSHIP OF

PROFESSOR R. PATRICK WRIGHT

F.H.A.S. F.R.S.E. PRINCIPAL OF THE WEST OF SCOTLAND AGRICULTURAL COLLEGE GLASGOW

VOLUME VI

FIS–HEM

THE GRESHAM PUBLISHING COMPANY

34 AND 35 SOUTHAMPTON STREET STRAND LONDON

LIST OF PLATES

VOLUME VI

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VOLUME VI

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The classic series of articles on insects by the late John Curtis have been embodied in the work, revised by Professor F. V. Theobald and Mr. Cecil Warburton, M.A., and bear the initials of J. C. and F. V. T. or C. W.

In like manner the great botanical articles of the late Professor John Lindley, which, like Curtis's articles above mentioned, were contributed to Morton's *Cyclopedia of Agriculture*, have, under Professor A. N. M'Alpine's revision, been embodied over the initials J. L. and A. N. M'A.

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE

Fish Guanos. See Fish Manures.

Fishing.—For purposes of sport, British freshwater fishes are divided into two classes—(1) *Game fish*, consisting only of Salmonidæ, viz. salmon, trout, char, and grayling; (2) *Coarse fish*, comprising carp, perch, bream, tench, dace, roach, rudd, chub, barbel, pike, &c.

The statutory close time for salmon fishing with the rod varies in the three kingdoms, and further variations have been made under by-laws passed by boards of conservators to suit the peculiar conditions of certain districts. Speaking generally, the close time for rods is arranged to cover the late autumn and winter months, when salmon should be on the spawning beds.

For freshwater trout the close time has been variously fixed in England by local boards. In the majority of rivers it covers the period from 1st October to some date in March. In Scotland it is fixed uniformly from 15th October to 28th February, both inclusive; in Ireland it corresponds with the close season for salmon fishing with the rod.

There is no statutory close season for coarse fish in Scotland or Ireland. In England it is fixed from 15th March to 15th June, except in parts of Norfolk and Suffolk, where it is regulated by a local Act, and in certain other districts which have been exempted from the principal Act. Where trout and salmon are well established, it would obviously be mischievous to protect pike and perch, which devour quantities of their young.

The popularity of all kinds of angling has greatly increased within the last sixty years, for, while salmon and trout fishing with the artificial fly are now reckoned among the higher branches of field sport, railway facilities have enabled the working classes in populous industrial districts to gain access to the waterside in immense numbers and from considerable distances. In midland and northern England, and in the mining and manufacturing districts of Scotland, the members of angling clubs may be reckoned by thousands. The value of such a source of recreation to a hard-working community can hardly be overrated, yet comparatively little has been done either to preserve our rivers from pollution with industrial refuse or to develop the practically illimitable resources of our watersheds for the production of fish.

Before offering some suggestions as to the manner in which this might be undertaken, brief notice may be made of the various modes of angling, and of the fishes predominating in different districts. For technical details, with which it would not be possible to deal in the space at command, there exists an abundant literature which may be consulted.

Salmon Fishing.—While it is admitted generally that salmon fishing is the premier form of angling, it must be confessed that it has the defect of exclusiveness. Although the rivers of the United Kingdom are naturally most prolific of salmon, in many of them the stock has been unduly reduced by excessive netting in the sea, in estuaries, and especially in the rivers themselves; while salmon have been wholly excluded from other waters where they once abounded (as in the Thames and the Clyde) by pollution and artificial obstructions. These causes have so contracted the range of the salmon angler as greatly to enhance the value of decent salmon fishing, putting it out of the reach of all except persons of ample means. It is true that there are parts of certain rivers where the fishing is open to all, sometimes free, sometimes on payment of a rod licence; but in such places the number of anglers is always so great as to render the chance of sport very slender for each individual. Indeed, under the most favourable conditions, salmon fishing must always be the lot of the fortunate few. In barbel or roach fishing, the angler baits his chosen swim and waits till the fish collect round him; give the trout fisher two or three hundred yards of stream and it will go hard with him if he does not find something on the rise; but the salmon fisher can only hope for success if he is free to range over a considerable 'beat', for salmon are always on the move; at least, those which remain long stationary are less likely than fresh-run fish to be tempted by any lure, and are worth little when they do succumb. It is the fish fresh from the sea that is the angler's prize. Let the fish be but two or three weeks (in hot weather but a few days) in the fresh water, and his lustrous coat becomes tarnished, his movements sluggish, and his flesh loses the crispness and flavour which make the salmon the king of food fishes.

The best season for fishing varies in different rivers in a very remarkable way. The early fish are those most sought after, because they are invariably in the finest condition; but nobody

knows what brings salmon earlier into one river than into another. It is not, as has been suggested, a question of temperature or of volume of water, for among the earliest rivers in the realm are the Brora, the Helmsdale, and the Thurso, all small rivers fed by melting snow and remaining intensely cold till well on in spring. Plenty of spring salmon run up these streams, if they happen not to be frozen up, in January and February; so they do in the Irish Bush, an insignificant little river flowing within a few miles of the sweeping Bann; yet no salmon enters the Bann till May. Again, the Hampshire Avon is a very early river, while the Irish Erne, six times its volume, is a late one. In rivers which maintain a good summer flow there is often good salmon fishing in June and July, provided a reasonable number of fish are allowed to pass through the nets. August is almost invariably a bad month for anglers and a good one for netsmen; matters mend in September, when the nets are off and what is known in some rivers as the 'blackberry run' of heavy fish sets in. After the close of that month very heavy fish are often taken, but it is the exception to get one that is not far advanced towards spawning. Nevertheless there are probably more salmon killed with the rod in October throughout the kingdom than in all the rest of the open season. The Tweed and a few other rivers remain open for rods during November, but the fish are in a condition which ought to be reckoned unseasonable.

Salmon are taken with the artificial fly, minnows or other small fish natural and artificial, worm and prawn. In some of the best rivers no lure is permitted but the artificial fly, which in the opinion of many good anglers is the only bait that ought ever to be presented to this fine fish. Fly fishing certainly excels all other methods in refinement, and, taking one day with another, is quite as efficacious as any. It has the advantage, moreover, of disturbing the water and the fish therein less than any other kind of angling. In the Tweed, only fly fishing is permitted after the removal of the nets on 15th September. In very deep water, such as Loch Tay or Loch Ness, it is futile to fish for salmon with surface lures. In such places they can be taken only with sunk spinning baits trolled astern of a boat rowed at a moderate pace. But in shallower lakes, where the fish lie within sight of the surface, fly fishing for salmon is most exciting sport, owing to the bold nature of the rise and the wild rush which the fish, on being hooked, invariably makes for deep water.

Grilse are salmon returning to fresh water for the first time since their descent as smolts. They generally make their first appearance in the rivers about the end of May, when they weigh from 2 to 5 lb. They continue to run throughout the summer and autumn, attaining towards the end of the season as much as 10 lb. weight. They give very lively sport, and often lie in parts of the river where salmon never tarry. Quite recently it has been ascertained, as the result of systematic marking of smolts with silver wire, which has been carried on in the Tay, that the small spring salmon from 5 to 10 lb. in weight, which form such a well-defined class in early rivers, are fish which have passed the grilse stage in the sea.

It is a curious fact that a large part of the fascination of salmon fishing is derived from a belief prevailing among fishermen that the salmon of each river require to be tempted by flies differing in colour, shape, and material to those used in other rivers. Hence the enormous variety of flies on sale in tackle shops; a recent work on the subject gave a list of upwards of 300 *standard* patterns! When it is considered that a salmon fly is not made to imitate any living creature, least of all a fly—that salmon do not habitually feed on flies, and, although they may occasionally take food into their mouths in fresh water, they never 'feed' there in the sense of taking nourishment—that the artificial fly is presented to the salmon in precisely the most unfavourable position for the discernment of colour, namely between the eye and a high light—it may safely be concluded that much of the artistic ingenuity of fly dressers and the extravagance of fly purchasers is a harmless sacrifice to imagination. The salmon angler whose experience is limited to one river may attach supreme importance to the precise shade of a hackle or the exact composition of a wing; but he who has cast his fly in many waters inevitably comes, sooner or later, to the conclusion that size is the only important thing to be considered in choosing a fly, and that the predatory impulse of the salmon can only be aroused by the motion given to the fly by the fisher.

Sea-trout Fishing.—Good sea-trout fishing is even more difficult to obtain in Great Britain than salmon fishing, although sea trout frequent many streams where salmon are seldom or never taken. Those who can afford it can generally command excellent salmon fishing, because beats on the principal salmon rivers are offered for hire every year. But the lesser streams which sea trout affect are seldom let except with shootings, and to obtain a good sea-trout fishing one may have to burden himself with a grouse moor or a deer forest. All round the Scottish coast, especially in Orkney, the Hebrides, and along the deeply indented western seaboard, there are streams and lochs in which, at times, most exciting sport may be had among sea trout with artificial fly. Many Irish waters also abound with these charming fish, which are known in that country as 'white trout'. There is a famous fishery of them at Ballinahinch in Galway, where a chain of lakes discharge themselves through a short river into the sea. Rods are let to visitors at the hotels of Ballinahinch and Recess at so much a day, with boat and boatmen, and very large baskets are made sometimes.

Sea trout will take worm or minnow readily, but these should never be used when there is a chance with the fly, for of all our native fishes the sea trout, weight for weight, affords the liveliest play when hooked on fine tackle. The largest sea trout begin to ascend the rivers early in June, and are frequently taken on the fly weighing as much as 5 or 6 lb. during that

month and July. In August a run of smaller fish begins, averaging about 1 lb. These are the grilse of the sea trout, and are locally known in Scotland as finnocks, herlings, or lammasmen. The rod and tackle for sea trout are identical with those for salmon, except that they are on a smaller, lighter scale. The flies are smaller than those generally used for salmon, though it is nothing unusual to hook salmon and grilse when fishing for sea trout, hence fairly strong gut should be used. The three classes of gut known as Padron 1st and 2nd and Marana 2nd are about the right thing; but any competent tackle maker may be relied on to supply proper sea-trout casting lines and flies.

The term 'sea trout' is somewhat ambiguous. The fish referred to above is that known to ichthyologists as *Salmo trutta*, which ought perhaps to be called the salmon trout. But there is another fish known to Tweed fishermen as sea trout, and in other rivers called bull trout, namely *Salmo cambricus* or *eriox*, inferior to the true salmon trout in everything but size, for although the flesh is richly coloured it is coarse and insipid, and the fish seldom rises at the fly. It is undesirably abundant in the Tweed and other rivers of the east coast. The bull trout of the Tay are a distinct variety, growing to a great size, as much as 40 lb. in weight. In Wales the name 'sewin' is applied commonly to both salmon trout and bull trout, and farther south the term 'peel' is used to designate the grilse of salmon as well as all kinds of sea trout. The varieties of migratory trout merge into each other in a very perplexing way; indeed, Scandinavian ichthyologists have solved the difficulty by classifying salmon, sea trout, and freshwater trout as varieties of a single species. The important matter for anglers is that the presence of bull trout ought to be discouraged in every possible way, and all means should be taken to protect and increase that most sporting fish the salmon trout.

Trout Fishing.—The common brown trout (*Salmo fario*) is the most accommodating of all the British Salmonidæ, thriving in all waters that are reasonably pure, and adapting itself to environment in a way that greatly modifies its size, colour, and general appearance. Thirty years ago Dr. Günther enumerated six distinct species of British non-migratory trout, but ichthyologists are now agreed that these are no more than local varieties, and that the gillaroo of Ireland and the *ferox* of the great lakes of Scotland and Ireland are identical in species with common brook trout. The form, colour, and size of this most plastic creature depend entirely upon food supply, water room, and the nature of the surrounding soil. This is most clearly shown by the dimensions attained by trout reared from British ova and naturalized in the rivers and lakes of New Zealand, where they attain proportions unheard of in the country of their origin. They acquire also in the southern hemisphere the anadromous or migratory habit of salmon, descending to the sea for food, returning to the rivers to spawn, and assuming the silvery coat of seagoing fish.

Trout are found in all parts of the British Isles, though they have been exterminated in many waters by their inveterate enemy the pike, which was widely distributed in pre-Reformation times by clerics and monks, who set great store by that most prolific fish as affording an easy food supply for fast days.

The modes of angling for trout are various, and the practice differs greatly according to the nature of the waters in each district. Fly fishing for trout has been brought to the greatest perfection in the south of England, where the extreme clearness of the chalk streams renders necessary the utmost delicacy of tackle, and the large average size of the trout demands much nicety of handling when they are hooked. Moreover, in order to delude these highly sophisticated fish one must present them with exact imitations of the natural insect which happens to be on the water at the time, and whereas many of these insects are exceedingly small, it is justly claimed for chalk-stream fishing that it is the most difficult and delicate branch of angling. To play and land a trout of 3 or 4 lb. on a hook not more than ⅜ in. long, attached to gut no thicker than horse hair, is a feat which might appear incredible to a north-country fisher, yet it is frequently performed in such streams as the Test, Itchen, or Kennet.

The old method of fly fishing, which is still universal in the north, in Wales, and in Ireland, is to attach two or three flies to the casting line, to throw them over all likely places in the water, letting them sink a little way below the surface, as in salmon fishing. That is called wet-fly fishing, or, by professors of the finer craft, the 'chuck-and-chance-it' style. But in the south the increasing wariness of the trout has caused the angler to adopt another system. Instead of flinging two or three flies at random over the face of the waters, he uses but a single fly, which he does not cast until he sees a fish rising at the natural insect. Approaching cautiously and throwing up stream, he places his fly a couple of yards above the feeding trout and allows it to float dry over the fish. In one respect, and one only, is dry-fly fishing simpler than the other system. Bright sunshine and still weather are obstacles to successful use of the wet fly, whereas they present no difficulty to the dry-fly artist. He only dreads a strong wind down stream.

The increased popularity of trout fishing, stimulated by railway and motor facilities, has vastly increased the value of south-country fisheries. For instance, in a fishing club formed in 1822 on the Hampshire Test, the annual subscription of twelve members was £10. The club now consists of sixteen members paying an annual subscription of £60—in all £960 as against £120, besides an entrance fee of £10 on election.

Trout are not so plentiful in the Midlands and eastern counties of England as in the northern and southern parts of the island. The exception is in Derbyshire, where there are some streams famed since Walton's time for the abundance and quality of their trout. In the other midland counties the absence or scarcity of trout is not owing to the character of the waters, for

these fish are not at all fastidious in that respect, but to the predominance of pike and other coarse fish. Pike destroy the trout themselves, while chub, dace, and others of the Carp family multiply apace, devouring the spawn of trout and the aquatic flies and other creatures which ought to go to the sustenance of the choicer race.

In Scotland and northern England trout streams are liable to run very low in summer, and the fish are generally numerous, but small. But the trout fishing in the Till of Northumberland, the Tweed, the Aberdeenshire Don, the Fifeshire Eden, the North and South Esk, and the Tay is of a very high quality indeed. As to the Scottish lochs, when these are not infested with pike, as is too often the case, they are invariably stocked with trout. Upwards of 34,000 were taken in Loch Leven with rod only during the season of 1908. Loch Leven, if left to itself, would swarm with pike, but these are kept down by systematic netting, and the stock of trout replenished by a well-managed fish hatchery. In the large and deep lochs of the Scottish Highlands, and in the great loughs of Ireland, trout attain a great size, but can only be taken by spinning baits at great depth. Any trout between 5 and 30 lb. weight is dubbed a *ferox*, and used to be scientifically classified as a distinct species. But there is no anatomical peculiarity to distinguish these large fish from ordinary *Salmo fario*, of which it is certain they are but robust specimens. Every season near Romsey trout are taken from the Test of from 8 to 14 lb. weight, which would certainly be termed *ferox* in the Highlands.

The *Char* is an exquisite fish, more beautiful than brown trout and more delicate on the table, but of little value from the angler's point of view, owing to the great depths at which they lie. In the English Lakes, however, they are regularly fished for with spinning bait on a plumbline, twenty char being reckoned an exceptionally good day's fishing, and six or eight an average day's take. (The best handbook to fishing in the English Lakes is Mr. John Watson's English Lake District Fisheries.) All species of char may be distinguished from salmon and trout by the absence of teeth on the vomer or palate bone.

Grayling are second only to trout in the esteem of anglers, indeed some fishermen prize this beautiful fish more highly than trout. But they have the disadvantage of being out of season in the sweet o' the year, when trout are at their prime. They spawn in April, and do not recover condition until late summer, attaining their best in October and November, when good fishing days are few and short. They have been widely distributed of late years, more so than some anglers consider desirable. They manifest a constant tendency to drop down to the lower reaches of the river in which they are placed.

Many thousands of the North American brook char (*S. fontinalis*) and of rainbow trout (*S. irideus*) have been turned into British waters of late years. They are both beautiful and desirable fish, and while young give excellent sport to the fly fisher, but both manifest an inveterate tendency to escape to the sea. Where rainbow trout have been permanently established, as in the Devonshire Tamar, they dwindle in size and deteriorate in condition, becoming inferior in both to the native brown trout. Moreover, they spawn, like grayling, in spring, and are not fit to be taken before August.

Coarse Fish.—The term 'coarse', applied to all freshwater fish other than Salmonidæ, refers to their inferiority as articles of food, and not to the modes of taking them with rod and line, which often requires as much delicate skill as can be displayed in fly fishing. For instance, the most accomplished salmon fisher would find himself at a loss to emulate the craft of a Nottingham angler, who, with gossamer line, quill float, and light-running reel, will fish a swim 100 yd. long without moving from his station, and strike a roach at any part of it.

Pike take first rank among coarse fish in virtue of their size, fish of 20 lb. and upward being far from uncommon. They are therefore highly prized by south-country anglers, though in Scotland they are reckoned the worst kind of vermin. They are seldom fished for in the north except with a spinning bait, which heavy fish do not often trouble themselves to take. If any skilful English pike fisher were to emulate the performance of Colonel Thornton in 1786, and use snap tackle and live bait systematically in Scottish and Irish waters, he would be welcomed as a benefactor by the owners of such waters, and might secure some splendid specimens. Colonel Thornton killed a pike of 48 lb. in Strathspey, and ninety years later, in 1876, one of 37½ lb. was taken in Lough Romer, Co. Cavan. Pike spawn in April, and are in the best condition during autumn and winter.

Perch are most sporting fish, bold in biting, strong in play, and excellent on the table. They are usually caught with worm or minnow, and occasionally they take the artificial fly. The most deadly method is the 'paternoster'—an arrangement of two or three hooks at different depths on a line and plummet. Perch spawn at the same season as pike, but recover condition more quickly, being at their prime from midsummer onwards.

Chub and *dace* take the artificial fly readily, but, like all others of the Carp family, are also to be caught bottom-fishing with worm, gentle, or paste. The *carp* itself grows to a weight of 12 or 15 lb., and gives exciting sport on fine tackle; *bream*, *roach*, and *rudd*, though worthless as food, multiply very fast, and afford plenty of occasion for the exercise of skill in their capture. The *barbel* is a most wary fish, feeding on the bottom, but requiring to be deceived by very fine tackle, which, as it sometimes exceeds 12 lb. in weight, makes the sport very exciting. In the British Isles this fish is found only in the Thames, the Trent, and a few other rivers flowing eastward. Having mentioned the principal kinds of coarse fish, we must refer the reader for information about the others, and the approved methods of their capture, to the publications noted at the end of this article.

DEVELOPMENT AND MANAGEMENT OF FISHERIES.—The failure of existing available waters to meet the increasing demand for angling facilities has given rise to much discontent, to impatience with the rights of private property, and to an agitation in some populous districts for 'free fishing'—that is, freedom for all men to angle in any water without charge. Now, apart from the objection to interference with private ownership, which need not be argued here, the ultimate result of throwing open fishing waters to all and sundry may easily be foreseen by anybody practically acquainted with the fisherman's craft. It would cease to be anybody's business or interest to protect fish; every accessible piece of water would very soon be overfished; and, forasmuch as anglers are an intensely competitive race, some of them would resort to methods of fishing quite incompatible with fair sport. The pot-hunter would flourish so long as the stock of fish held out, but the 'contemplative man's recreation' would be gone. Free fishing, in short, would come to much the same end as free strawberry beds or free cellars; no sensible man would be at the trouble to rear fish, grow strawberries, or lay down wine. The proper way to meet the laudable desire of the community for fair angling is to follow the example set by the Government of the State of New York in improving existing fisheries, creating new ones, and committing them to the management of properly constituted angling associations. The following observations are intended to show how much may be done in this direction.

Salmon.—Efforts have long been in progress to counterbalance the ever-increasing depletion by netting of the principal salmon rivers. Hatcheries have been established for a great number of years at Stormontfield on the Tay, and at the mouth of the Spey; and, more recently, numerous private hatcheries have been conducted with more or less success on various other rivers. It is a comparatively simple matter to net spawning salmon, fertilize the ova of the female with the milt of the male, and to rear the fry in boxes supplied with pure running water. But although it is a common thing to hatch 90 or 95 per cent of the ova collected, it is very doubtful whether operations have ever been conducted in this country on a scale large enough to have any appreciable effect upon the stock of salmon. On the Pacific coast of North America, where the Government subsidizes and co-operates with private enterprise, and where upwards of 500,000,000 salmon fry were liberated in 1907, it is claimed that the Columbia River, having been almost cleared of the Pacific salmon by excessive netting and trapping, has been rendered productive again as the result of the output of the hatcheries. But in British waters not a single example can be shown of any increase of salmon traceable to hatchery operations; nor can anybody who has witnessed salmon smolts descending to the sea in countless myriads from the natural spawning beds feel any confidence in the good effect of turning in 200,000 or 300,000 fry to run the gauntlet of their many natural foes. Not to mention pike, which abound in many salmon rivers, the common brown trout lies in wait for the descending shoals. The writer has taken ten fine smolts from the stomach of a single trout weighing, with its contents, 2 lb.—without them, only 1 lb. 6 oz. This trout had enough appetite remaining after its meal to take a large salmon fly. Any good that may result from artificial propagation of salmon on a moderate scale is probably outweighed by the mischief done in disturbing the breeding fish by netting them during the most critical operation of their lives.

The true way of averting the depletion of salmon rivers by netting is to secure free access to the upper waters at all times for a portion of every run of fish. It was the intention of the legislature to provide for this by instituting a weekly close time for nets—42 hours in England, 36 hours in Scotland, and 48 hours in Ireland, but the provision is ineffective. In large rivers, the fish that pass the sea and estuary nets on Saturday and Sunday are taken by the upper nets on Monday morning. In small rivers, during summer droughts the water is often so low as to make it impossible for fish to run. They hang about the estuary waiting for a flood, while the nets play unrestricted havoc among them. The effective remedy for this is water storage, which might be contrived at moderate cost near the sources of most of our salmon rivers. It has been done most successfully for the Helmsdale of Sutherland by raising the level of two or three lakes at the head of the strath. Before this was undertaken, the spring angling used to end when the snow water had all run off, about the end of April; the water fell away to a mere trickle; angling there was none till the autumn floods, which enabled the fish to ascend the river from the sea. Now the sluices are opened early in May, and give a full river, with excellent angling, until the end of July, when the Lammas spates usually take place. By a capital outlay of about £2000 the annual angling value of the fishery has been doubled, and the sea nets derive their share of profit from the greatly increased stock of fish belonging to the river.

Trout.—The creation or development of a trout fishery is a far simpler thing than it is in connection with salmon, for, while the collection, fertilization, and hatching the ova is as easy and certain in one case as the other, trout can be kept under observation and protection in all stages of growth. There is practically no limit to the number and extent of trout fisheries which might be created in the United Kingdom. Wherever a rivulet runs there is the means of forming a reservoir, wherein trout which in their native brook might never exceed a few inches in length and a few ounces in weight, will attain dimensions proportionate to the food at their command.

First as to the *development* of natural trout water, Loch Leven has been cited above as an example of good management. The following table shows the number and weight of trout and pike taken therein in nine years. It will be noticed that in this, as in all trout waters, the average weight diminishes in direct ratio to the number of fish, a given supply of food serv-

ing to nourish either comparatively few large fish or a larger number of small ones:—

Season.	Number of Trout taken by rod.	Average weight in lb.	Number of Pike killed.	Total weight of Pike.
1900	23,811	·654	No record.	No record.
1901	18,165	·744	,,	,,
1902	7,869	1·054	,,	,,
1903	2,137	1·37	3,725	14,074 lb.
1904	5,523	·90	2,029	3,885
1905	8,494	·90	876	1,938
1906	17,171	·85	166	408
1907	22,851	·83	No record.	No record.
1908	34,110	·779	332	507

The area of the loch being about 3400 ac., the yield in 1908 was equal to ten trout per acre.

Next, as to the *creation* of a trout fishery. The most conspicuous instance of success which has come under the writer's notice in the United Kingdom is that of the Blagdon Reservoir, Somersetshire, one of the sources of Bristol water supply. It covers 450 ac., and was stocked in the winter of 1898–9 with 1500 two-year-old trout from that loch. In 1905 two gentlemen fishing with artificial fly on two consecutive days killed thirty-seven trout weighing 171 lb., the heaviest being 8½ lb., and the average weight 4⅝ lb.

Much disappointment has been caused by the faulty construction of trout ponds. No matter how small the stream is, the pond is sure to silt up if it is made by simply throwing a dam across the channel. The pond should be made clear of the stream altogether, and fed by a pipe or open runner regulated by sluices from the main stream. (Practical instruction as to this and many other points in the creation and management of trout fisheries is given in An Angler's Paradise and how to obtain it, by J. J. Armistead, Scarborough.)

Coarse Fish.—If British housewives were as dainty cooks as those of Continental nations, coarse fish would be more highly esteemed than they are. Anybody who has eaten a *friture* of tench from the Loire must deplore the neglect of the inexhaustible food supply in British waters. While it is improbable that occasion should arise for creating a coarse fishery, organization is the only thing needed to improve our existing canals, ponds, and rivers, where coarse fish already are found, so as to make them better sources of recreation to the angler of modest means. The perch is the gamest of coarse fishes, as it is the best on the table, and perch may be multiplied indefinitely by artificial hatcheries. There is no better way of improving a coarse fishery than by turning in plenty of perch, which will keep down excess of inferior kinds, such as chub, roach, and bleak. Suitable provision for getting up a stock of pike, perch, and other coarse fish is easily made. It only requires to have command of an extent of suitable water, and facilities are seldom refused by public bodies and private owners, when the management of the fishery is entrusted to a respectable committee.

[Besides the excellent treatises on the various branches of angling contained in the Badminton Library, the Fur, Fin, and Feather Series, and the Encyclopædia of Sport, the following may be mentioned as being among the most useful modern works on the subject: A Book on Angling, by F. Francis; Fly Fishing, by Sir Edward Grey; The Practical Angler, by W. C. Stewart; Salmon and Sea Trout, by Sir Herbert Maxwell; Dry-fly Fishing, by F. M. Halford; The Book of the Dry Fly, by G. A. B. Dewar; Pike and Perch, by Alfred Jardine; Coarse Fish, by C. H. Wheeley.]

[H. M.]

Fish Manures.—Fish refuse and waste fish have been used from time immemorial for manurial purposes. About fishing villages it has long been the practice to use the heads and guts of fish, together with worthless, damaged, or decomposing fish, and the shells of shellfish, for application to the land.

After guano came into use it was soon suggested that as guano is derived from the refuse of birds which feed on fish, a somewhat similar substance might be made from refuse fish itself. Great quantities of refuse fish or waste of fish were available about centres of the fish industry in England, France, Norway, and Newfoundland, and these appear to have been the countries in which the earliest efforts were made to prepare fish manures. The manufacture was started in these countries about 1850, or at any rate not long after that date. It did not attain to very great proportions till after 1870, when the supplies of Peruvian guano began to run short, and when therefore a great demand began to arise for other organic nitrogenous and phosphatic manures to take its place. Another circumstance which has tended to the increase of the manufacture of fish guano in recent times is the concentration of the fishing industry in great centres owing to the increased use of steam vessels for fishing. It does not pay to set up a modern fish-manure factory in a small fishing village where only a small amount of fish refuse is available, but when fishing becomes concentrated in great centres like Grimsby, Hull, and Aberdeen, large and constant supplies of fish waste become available at such centres. In fishing villages the small quantities of waste available can be applied directly to the surrounding land, but in large centres this cannot be done, and as the waste, which soon becomes very offensive, has to be got rid of somehow, the fish-manure factory naturally springs up to dispose of this by-product.

In the early days of the manufacture of fish manure, the appliances used were very primitive. The fish refuse was merely spread out on heated plates and the moisture evaporated off into the air. The resulting product, when sufficiently dry, was ground to a rough powder. In some cases the waste was merely spread out in the air and dried by the heat of the sun. Crude processes of drying on open plates or in pans are still carried on to a limited extent at some of the smaller factories which are removed from centres of population, but they have largely been replaced by more economical and less offensive methods of desiccation. Open-pan drying of fish refuse is a very offensive process, which would not now be permitted in or near any centre of population. Besides, the products

obtained by these crude processes are dark in colour, variable in texture, and of poor composition.

In modern plant the fish is dried in closed steam-jacketed pans, from which the volatile products are exhausted by suitable pumps or fans, and passed through coolers and condensed. In well-conducted modern factories little strong-smelling vapour is allowed to escape to the atmosphere, and the offensive nature of the industry is reduced to a minimum. The product obtained, too, is generally of good colour and texture, and fairly uniform in quality. There is practically no loss of anything of fertilizing value during the manufacture. In the case of oily fish such as the herring, or of oily portions of fish such as the livers, the oil is often removed to a large extent for use in soapmaking, before the manure is made. This not only improves the quality of the manure, but gives another valuable by-product, fish oil.

Fish manure is commonly known as fish guano. Such terms as fish powder and fish meal are also sometimes applied to it, though the term fish meal is now commonly reserved for dried and powdered fish which is intended for use as food for poultry and other farm animals, or even for human consumption. The manurial value of fish guano depends mainly on the nitrogen and phosphates which it contains. Fish flesh when dry and free from fat and other impurities contains, like the flesh of other animals, 15 or 16 per cent of nitrogen, and only a very small percentage of phosphate and other ash constituents. On the other hand, fish bone, like other animal bone, consists largely of phosphates, but contains also some highly nitrogenous organic matter (see BONE MANURES). Dry fish bone contains 50 per cent or more of phosphates, together with about 4 per cent of nitrogen. Fish guanos generally contain both bone and fleshy materials. If they contain much bone the phosphates will be correspondingly high and the nitrogen low, while if they contain much flesh and little bone the nitrogen will be high and the phosphates low.

In addition to the nitrogen and phosphates, fish manures also contain a little potash, but the percentage of this is so small as to be quite unimportant. Another secondary constituent is lime. In fish bone, as in ordinary bone, there is a little lime present in excess of that necessary to combine with the phosphoric acid, and this has a small manurial value.

Fish manures vary greatly in nature and composition according to the nature of the materials from which they are made, their purity, and the method of manufacture. Sometimes fish manures contain a good deal of salt and other extraneous matter of little or no manurial value, and in proportion as these are great in quantity the percentages of nitrogen and phosphate will be low, and the value of the manure will be diminished.

In Scotland the two leading varieties of fish manure made are white-fish guano and herring guano, which is often called fish powder. White-fish guano is made from the heads, bones, and waste of haddocks, cod, ling, and other non-oily fish. It generally contains from 7 to 10 per cent of nitrogen, equal to from 8½ to 12 per cent of ammonia, and from 12 to 20 per cent of phosphates. But samples are sometimes met which fall outside these figures. Thus a quality is made, especially for the foreign market, which contains very little bone, and which may contain as much as 12 per cent of nitrogen, equal to 14·6 per cent of ammonia, but only 3 or 4 per cent of phosphate. White-fish guano ordinarily contains from ½ to 1 per cent of potash. It contains little oil.

Herring guano is not of such high quality. It generally contains much more oil than white-fish guano, and sometimes contains a good deal of salt as well. Partly on account of the presence of these substances, and partly because much of it is made with comparatively crude machinery, it frequently contains much more moisture than the white-fish manure. The presence of all these valueless substances reduces the percentages of the valuable manurial ingredients nitrogen and phosphates. The nitrogen present varies generally from 5 to 7 per cent, equal to from 6 to 8½ per cent of ammonia, though samples with less than 5 per cent of nitrogen are sometimes met with. The phosphate estimated as tribasic phosphate of lime generally varies from 8 to 12 per cent. There is seldom more than ½ per cent of potash present.

The following table gives some analyses of Scotch fish manures:—

	White-fish Guano.	Herring Guano		
		Good sample.	Sample with much salt.	Damp inferior sample.
	per cent.	per cent.	per cent.	per cent.
Moisture	14·67	21·24	22·94	37·02
[1] Organic matter	64·53	59·66	44·46	41·23
[2] Phosphoric acid	8·11	5·17	5·25	3·54
Lime	8·67	5·02	5·40	3·16
[3] Magnesia alkalis, &c. (by difference)	3·57	5·44	21·10	13·51
Siliceous matter	0·45	3·47	0·85	1·54
	100·00	100·00	100·00	100·00
[1] Containing nitrogen	9·58	6·83	5·22	4·68
Equal to ammonia	11·63	8·30	6·34	5·68
[2] Equal to tribasic phosphate of lime	17·69	11·29	11·45	7·72
[3] Including common salt	—	2·74	18·53	12·14

The analysis of the white-fish guano given above is a typical one of a good well-dried sample. The herring guanos are of various qualities. The inferior sample shown in the third analysis is a type not infrequently met with. When there is so much moisture present, the manure is apt to heat and ferment during storing. It then not only becomes very offensive, but loses value by becoming dull and dark in colour, and lumpy and sticky in texture. During heating also it may lose a little ammonia, and this of course lowers its value. Well-made samples should not contain much more than 20 per cent of moisture, and samples considerably drier than this are occasionally met with.

The presence of oil in fish manures diminishes their value to a certain extent. The oil itself has no manurial value, and it acts to a certain extent as a preservative, and prevents the rapid decay of the other constituents of the manure, and hence lowers their availability to plants. In white-fish manure the oil is, generally speaking, not over 4 per cent, and samples are sometimes met with containing less than 2 per cent. So small an amount of oil is quite negligible. On the other hand, in herring manure the oil often exceeds 10 per cent, and is seldom or never under 5 per cent. The harmful effect of this oil has sometimes been exaggerated. Its presence renders the manure a little slower in action, and weight for weight of nitrogen and phosphate a little less effective. But even when 10 per cent of oil is present, it has been shown by experiment that this retarding action is not very serious.

Many other qualities of fish manure are made in different places. They vary from manures made almost entirely from flesh and other nitrogenous materials, which are therefore rich in nitrogen and contain very little phosphate, to manures composed largely of bone, which are therefore rich in phosphate and comparatively poor in nitrogen. Samples rich in bone may contain upwards of 30 per cent of phosphate. Occasionally manures are made entirely of ground fish bone, in which case they may contain over 50 per cent of phosphate, with about 4 per cent of nitrogen.

Fish manures are highly esteemed and fetch a high price. In their action they resemble manures made from the flesh and bones of cattle, such as meal guanos and bone meals. On account of the greater quantity of nitrogenous organic matter which they contain, they are more rapid in action than bone meals, but they are never quick-acting forcing manures, and are gradual and safe in their action. It is perhaps partly due to this characteristic that they are so popular.

The greater part of the manurial value of fish manure resides in the nitrogen. Before this can become available to plants, the protein substances in which it is contained have to undergo decay and form ammonia compounds, which in turn have to undergo nitrification. Fish manure, therefore, must lie in the soil for some time before any part of its nitrogen is taken up by plants. As it only gradually undergoes decay and nitrification, its nitrogen only becomes available little by little, and its action is therefore prolonged. The phosphate of fish manure is similarly slow and prolonged in its action.

Fish manure is largely used by the makers of high-class mixed manures. This also causes a large and steady demand for it, which helps to keep up its price. The makers of high-class mixtures like to include in such mixtures a certain proportion of an organic manure such as fish, first, because it helps to keep the mixture open in texture and in good condition, and therefore easy to work mechanically; second, because it makes the action of the manure on crops more gradual and prolonged than if the nitrogen, for instance, were entirely derived from quick-acting mineral substances like nitrate of soda and sulphate of ammonia.

Mixed manures are sometimes made with a basis of fish guano. What is known as equalized fish guano has potash salt and soluble phosphate added to the raw fish manure. Other manures known by various names, but often classed together as fish compounds, or compound fish manures, are mixtures of fish guanos with various proportions of other substances.

Owing to their limited supply and to the great demand there is for them, the price of fish manures is sometimes so high that it is not economical for farmers to use them. When the nitrogen and phosphates in them cost distinctly more per unit than the same ingredients in bones, they should be avoided, as they are then too dear. [J. H.]

Fistula.—An abnormal opening in living tissues is called a fistula; as when injured tissues deep in the withers or within the foot need drainage, and nature develops a pipe or canal from which the inflammatory products are discharged. If left alone, the dead tissues or foreign body which gave rise to fistula will eventually drain away, as with wild animals or horses left in the bush; but the process is so slow that the patient may die of old age while waiting for a cure. Or the impediment may be of an insoluble character, as a nail or other foreign body, and surgeons therefore cut down upon it, or use destructive substances to produce a slough and enlarge the orifice, when the cause is removed and a wound left which is easily healed. See FISTULOUS WITHERS and QUITTOR. [H. L.]

Fistulous Withers.—When the pressure of the riding or harness saddle bruises the deeper tissues, the immediate consequences are not always visible, as they are when the skin is abraded or galled or a superficial abscess results (see ABSCESS). The dense fibrous material connecting the muscles to the bones or the ligaments acting on the long spinous processes of the dorsal vertebræ may be so injured that repair by resolution of the inflammation cannot take place, and matter must form and eventually find an exit. During this time, increasing tenderness and swelling is observed, and when finally the matter escapes through an opening made by the lancet, or by thinning of the skin and pointing (see ABSCESS), the attendant is disappointed to find that the wound does not heal, but that a little round hole remains (see FISTULA) from which a variable discharge takes place. This indicates the presence of some dead or dying

tissue, which must be removed before proper healing can take place. In this situation it is found best to introduce setons (see SETONS) dressed with some corrosive substance, as perchloride of mercury, arsenic, copper sulphate, &c., by which a larger wound is made, and drainage effected from a point lower than the seat of the mischief. It is found by experience that a considerable time should be allowed before removing the seton and permitting the fistula to heal. [H. L.]

Fits.—Our pathological knowledge of fits is but very slight, nor has any recent light been thrown on the subject. Cataleptic or epileptic fits have been referred to under those headings, but there are other seizures or sudden conditions of unconsciousness, and of movements without co-ordination and involuntary in character, which the general reader would term fits. These are observed chiefly in young animals, and have some relation to digestion and dentition, occurring without warning, but often traceable to unsuitable food, constipation, delayed cutting of the secondary teeth, the presence of worms, and as the result of injuries from external violence. What is the exact nature of the fits is still undetermined, when removal of the above-named causes has led to their cessation. Apoplectic fits and fainting fits are induced by opposite causes: brain pressure in the first case, and an insufficient amount in the second. In anthrax a fit of delirium is not infrequent, the animal falling to die, after a short, mad gallop. Fits of megrims (see MEGRIMS) and of mad staggers are considered elsewhere, and the post-parturient fits known as eclampsia. *Treatment* consists in removal of the cause where this can be ascertained, and a careful regard to diet, and avoidance of anything approaching to constipation of the bowels. [H. L.]

Fitzherbert, Sir Anthony, one of the earliest English writers on agriculture, and one of the most sagacious. A judge in the Court of Common Pleas, Sir Anthony turned to farming as a recreation after the fashion somewhat common among distinguished men in the 16th century. In 1523 he published his Boke of Husbandry, and in the same year or a little later his Boke of Surveying, works long regarded as the best guides on their subjects. Fitzherbert was a strong advocate of the enclosure of land, and the consolidation of farms by exchanges between neighbours of the scattered plots so common in his day. He did not approve, however, of the high-handed and unjust measures of enclosure adopted by many lords of the manor. His judgment on points of practical farming was remarkably enlightened for his period, and he made a close guess at the origin of fluke disease in sheep. He recognized, too, the hindrance to agricultural advancement due to the lack on the part of a tenant of security for his improvement. [W. E. B.]

Fixation of Nitrogen. See NITROGEN, FIXATION OF.

Fixed Oils are non-volatile oils, or oils that undergo decomposition when they are distilled either alone or with steam. See OILS.

Fixtures.—The law as to fixtures has been modified by statute in the case of agricultural fixtures. That branch of the law has been dealt with in the article on the Agricultural Holdings Acts (which see). This article is confined to the common law. A fixture originally meant something in itself of a movable nature which has become so attached to the soil as to belong to the owner thereof. This view is based on the principle of Roman law, that whatever is built, planted, or sown in the soil belongs by accession to the owner of the land. In the earlier history of the law this principle was strictly carried out, and any article, though movable and not necessarily attached to the soil, immediately on being annexed to the land fell in to the absolute possession of the landlord. Considerations of trade and equity have considerably modified this view. At the present time the term fixture has altered its significance, and usually comprises what are known as landlord and tenant's fixtures. Landlord's fixtures are those movable goods placed on the land either by the landlord himself or by the tenant which the latter is not entitled to remove, while tenant's fixtures are such movables affixed by the tenant as he is entitled to remove at or before the expiry of the tenancy. The question whether a tenant's fixture may or may not be removed depends on (1) whether or not there has been effective annexation, for the article must be actually fastened or connected with the soil, not in mere juxtaposition to it. Thus a wooden barn resting on beams or on supports which are fixed on to the ground is not regarded as a fixture. (2) Even where the article is unquestionably attached to the real property, it may, owing to the *mode* of annexation, still be removable by the tenant. Thus where the article 'can easily be removed in its entirety, in good condition, and conveniently, without injury to itself or to the fabric of the building', it will be removable by the tenant. (3) The intention with which the article was fixed may decide the question of its removability. Thus articles affixed by a tenant to a house for ornament or decoration, or for his personal use and convenience and designed for a special purpose, are removable by him. Thus carpets, pictures, mirrors, cornices, which could be severed without injury to the premises, if erected by the tenant, are all removable by him. Ordinary mantelpieces are as a rule fixtures, but purely ornamental chimney pieces have been held to be movable. Grates and stoves built into chimneys, and gas fittings, are all removable, but doors and windows are not. Wallpapers are of course not removable, but tapestry hangings as a rule are, although tapestry put up instead of a paper may be fixed so as not to be removable. But where the article, even though for ornament or convenience of the tenant, is so designed as to permanently improve the premises, or where substantial damage will be done by the removal, the article will be held to have become the property of the landlord.

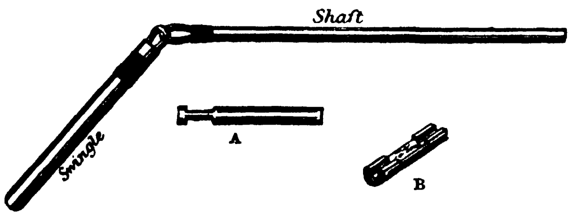
TRADE FIXTURES.—A considerable relaxation of the original rule of law was early introduced in the interests of trade, as it was felt that but for some such relaxation no tenant would lay out money in proper equipment of his business.

Constructive Fixtures. — Articles may become the property of the landlord by what is known as constructive annexation. Thus the grinding stone of a flour mill, the keys of a building, or small pieces necessary to the use of a machine, itself not removable, though lying loose, would all be held to be heritable.

Removal of Fixtures. — As a general rule, this must be at or before the termination of the lease, or during 'such period of possession by the tenant as he holds the premises under a right still to consider himself a tenant'. The tenant must do as little damage as possible, and must make good any damage he does in the removal. [D. B.]

Flag.—Two distinct genera of plants are included under this term—the Sweet Flag (Acorus) and the Water Flag (*Iris Pseudacorus*). See Acorus and Iris.

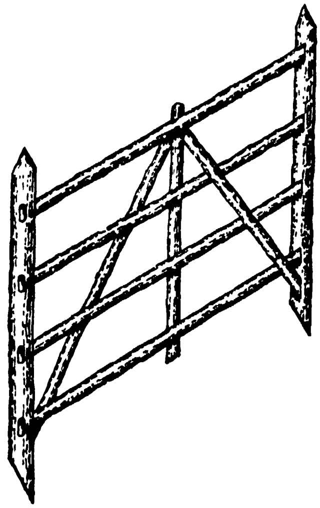
Flail.—Flails are used but little now except to thresh small lots of corn; but are useful for threshing some crops, such as peas and beans, to provide seed, as the seeds are not so liable to be split as by a threshing machine. The flail consists of two parts—the shaft or handle, and the swingle or swiple; the former is best made of ash, and the latter of hardwood not prone to split, such as well-seasoned whitethorn. They are coupled together with an ash swivel attached to the shaft, a loop of white leather bound on to the swingle passing through the bow of the swivel, free movement thus being given to the swingle. The swivel is made by splitting in half a piece of ash about 8 in. in length, then sawing out the greater thickness of the middle part, leaving the full thickness about 1 in. at either end. The wood is then boiled to give it pliability, so that it will bend without breaking when the two ends are brought together. A piece is then scooped out of either end, so that it will embrace the head of the shaft, a corresponding piece having been cut out near the top so as to form a bed for it to lie in. Having been fitted it is securely bound, and the flail is complete. The two pieces, however, are often connected solely by leather thongs, without an ash swivel. [W. J. M.]



Flail

A, Head of shaft prepared for swivel, to give freedom in swinging. B, Piece of ash cut ready to boil. When softened, it is bent to make swivel for shaft.

Flakes. — Flakes are stout gate hurdles, practically light gates without hinges, used for penning animals in the fold, the market, show-yard, or other place. In some districts the terms slatted hurdle or gate hurdle are commonly used. The best wood for making flakes is that from oak, chestnut, and ash, though willow, hazel, fir, &c., are freely used. Rent or riven wood is preferable to that which is sawn. The heads of the flake are mortised to hold the slats or flakes, which may be in any number, from three upwards, according to the purpose for which the completed hurdle is used. Diagonal braces from the top centre to the heels of the hurdle, and a centre vertical stretcher, give strength and keep the slats in position; usually these are nailed, but on stout oak flakes used in the south-east of England bolts and nuts are used, and iron rings are placed on the heads to prevent their splitting when being driven into the ground. In some districts the hurdles are held in the ground by the heads, which are produced to give sufficient length for them to keep firm. In others little reliance is placed on the head, separate stakes with bonds or shackles being used. [W. J. M.]



Flake

Flat Pea. See Lathyrus sylvestris.

Flatulent Colic. See Colic.

Flavour is that quality of a substance which affects the sense of taste. Most fragrant and odorous substances possess characteristic flavours, although the quality is not confined to that class of body. A flavourless substance is one possessing no quality affecting the sense of taste. Edible plants and substances possess a pleasant flavour, though individual taste varies enormously in its estimate of what constitutes a rich and agreeable flavour. Edibility and flavour are two properties most intimately related, in fact the former is largely determined by the latter; a pleasant flavour to one person may be most repugnant to another. Pleasant flavours are not confined to edible substances, as some plants though relished by cattle are actively poisonous.

Flavour can be made use of as a commercial property, in the sense that some feeding-stuffs, though not relished by cattle, are, after

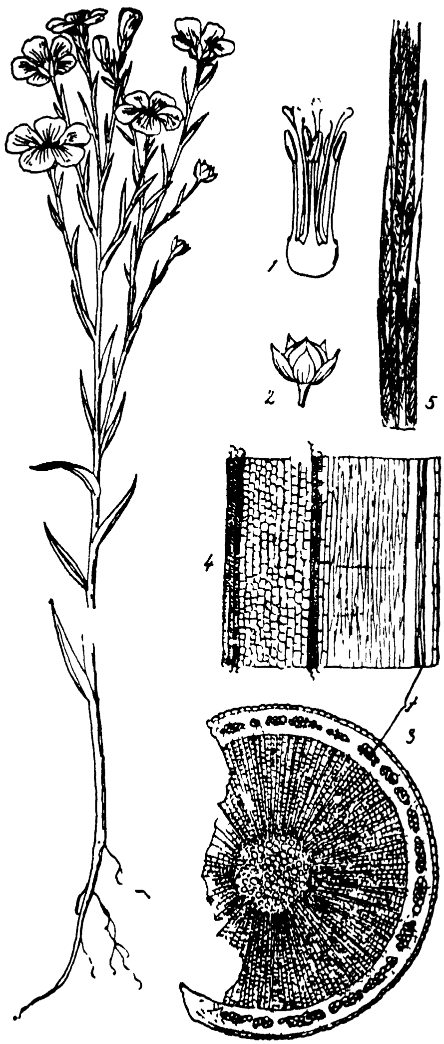
the addition of condiments or flavouring substances, made edible, palatable, and sometimes very attractive as a foodstuff. The quality and value of butter, cheese, &c., and many plants are determined largely by the possession of a rich flavour, and likewise in valuing cattle foods palatability and flavour are prime factors; also in the preparation of sweets, beverages, &c., flavour is the quality that often determines their sole intrinsic value. Flavour is due either to the presence of one definite chemical body or to several; more often flavour is the result of a combination of factors. [R. A. B.]

Flax.—Flax, or Linseed (*Linum usitatissimum*, L.), belongs to the nat. ord. Lineæ, and has been cultivated from very early times for its fibre, which is woven into linen fabrics. It is also grown for its seeds, which contain oil, and are sometimes used as food for animals. More often the residual product, left after the extraction of the oil from the seeds by pressure, comes into the market as the well-known 'linseed cake'.

The annual flax usually grown has a slender, upright, solitary stem from 1 to 2 ft. high, branched only in the upper part, which bears the flowers. In the bast tissue are bundles of long fibres, each well-developed bundle consisting of twenty to thirty strong fibres pointed at both ends. When isolated from the rest of the tissues of the stem, they are yellowish or 'flaxen' in tint with a silky lustre. The leaves are alternate, narrow, lanceolate, and glaucous. The flowers are pale-blue, about 1 in. across, with thin petals, five stamens, and a ten-celled ovary which ripens into a leathery capsule divided by partitions into ten boat-shaped valves, each containing a single seed. The seeds are oval, flattened somewhat, with pale-brown, shining, slippery coats; the outer epidermal cells of the testa swell up into a slimy mucilaginous substance when the seeds are soaked in water. The cotyledons of the embryo contain from 31 to 39 per cent of linseed oil, and 20 to 25 per cent of proteins. The oil is chiefly used in the preparation of oil paints and varnishes, and in the manufacture of soap and oilcloth.

Several closely allied forms are met with, all apparently belonging to the one species, *L. usitatissimum*). The common annual flax (*L. u. vulgare*) has capsules which do not open or shed their seeds when ripe, and the partitions within the capsules are smooth. Another variety (*L. u. humile*) has shorter stems, more inclined to branch, and capsules which suddenly open and scatter their seeds when ripe; the latter are paler in colour than those of the previous form. The narrow-leaved flax (*L. angustifolium*, Huds.) very closely resembles the ordinary annual species, but is usually perennial and has several branched stems, although biennial and annual forms are known. This plant, wild in southern Britain and in Europe and western Asia, was grown in prehistoric times in Switzerland and northern Italy before being replaced by the common annual flax. [J. P.]

Cultivation.—Flax was formerly extensively cultivated for fibre purposes in Great Britain, and even recently there were working in Yorkshire two central retteries and scutch mills. This crop has now almost entirely gone out of cultivation in England and Scotland, the flax-spinning mills of Dundee being dependent upon foreign fibre. In Ireland there has been a very considerable decline in the area devoted to flax, for although in 1908 there were 46,900 ac.,



Flax (*Linum usitatissimum*)

1, Stamens and pistil. 2, Fruit. 3, Section of Stem 4, Long section of stem. 5, Flax fibre (The bracket between 3 and 4 indicates the flax fibres *in situ*.)

almost all in Ulster, no less than 301,700 ac. were under flax in 1863. With the exception of Russia and Hungary, there has also been a marked decrease in acreage in all the other chief European flax-growing countries, viz. Belgium, Holland, France, Germany, Austria, Italy, and Roumania. In Hungary there has of late years been a slight extension of the area devoted to flax, but in Russia the development

has been most striking. It is estimated that in that country in 1885 there were 3,250,000 ac. under flax, and ten years later 5,480,000 ac.

Various reasons for the decline of the flax-growing industry in the United Kingdom have been advanced. Chief among these are: (1) the export of large quantities of cheaply produced flax from Russia, and the consequent fall in price of home-produced fibre; (2) that as the many operations connected with the flax crop must be performed by hand, and have often to be carried out when the corn harvest is pressing, the crop is now too costly and troublesome as compared with former years when labour was cheaper; and (3) the sowing of inferior seed, which naturally yielded poor crops.

In Ireland flax is grown exclusively for fibre, and the seed is not utilized. By paying attention to details, growers are able to produce a good quality of fibre, much superior to Russian, though not generally so good as the best Belgian or Dutch, and which therefore commands a price which still leaves remunerative returns. On the continent of Europe flax is grown for both seed and fibre; in India, Argentina, the United States of America, and Canada, almost solely for the seed, linseed, though attempts are now being made in those countries to prepare the fibre from the flax straw, which is otherwise useless when the seed has been removed.

The flax crop in the United Kingdom must be considered from the standpoint of fibre, and the seed will either be neglected, as is done in Ireland, or, in any case, will be a very minor consideration. The following notes will therefore deal mainly with the cultivation of flax for fibre purposes, particular reference being made to the practice of Ulster farmers.

For flax a rich kindly loam is most suitable, though good crops are often grown on clay, and fair yields obtained on sandy and peaty soils. In certain districts the following rotation is adopted: 1st year, lea oats; 2nd year, roots; 3rd year, oats; 4th year, flax sown down with grass and clover seeds; 5th year, seeds hay; 6th, 7th, and possibly 8th and succeeding years, pasture. This rotation is open to two objections: (1) that the lower or root end of the flax stems is damaged by the grass and clovers, and (2) that the land so laid down to grass is very weedy. In other localities flax is therefore sown between lea oats and roots in a rotation similar to the above. Another practice is to take flax after roots. Flax should not be sown on lea, owing to its liability to lodge when grown on land in too high condition, and also to the great danger of damage by the leather-jacket grub, the larva of the Crane fly (*Tipula oleracea*), which readily feeds on young flax. Neither should flax be sown on the same field at too frequent intervals.

A fine but firm seedbed is required. To obtain such on heavy land, autumn or early winter ploughing of the oat stubble is resorted to, followed by the usual cultivating, rolling, and harrowing operations in spring. Where flax is to follow roots, cultivation may be deferred until February or early March. If flax is sown on land which is in too high condition there is danger, as already mentioned, of the crop lodging, and in any case there will most probably be produced a large bulk of soft, green straw, which, when retted and scutched, will give a poor yield of low-quality fibre. Farmyard manure is therefore never applied directly, but given to a previous crop. The same may be said with regard to lime.

Extensive experiments in Ireland have shown that of the artificial manures only those containing potash are useful for direct application to the flax crop. Muriate of potash at the rate of 1½ cwt. per statute acre has proved the most profitable dressing, and 5 cwt. kainit per statute acre has also given remunerative returns. Such an application may be given at seedtime or during the previous winter. A dressing of either of these manures is preferable to an equivalent amount of sulphate of potash. In addition to producing a higher yield of better-quality fibre, potassic manures check a fungoid disease, known as 'yellowing', to attacks of which flax is subject, particularly on light soils in the early stages of its growth. The term 'yellowing' sufficiently explains the appearance of a diseased crop, which, however, is often said by growers to be frosted. This opinion has now been refuted in two ways: (1) by manurial experiments, and (2) the identification and study of the particular fungus, *Asterocystis radicis*, causing the disease.

It is of the utmost importance to obtain seed of the highest quality for sowing purposes, and the question of seed supply must therefore be discussed in some detail. Sowing seed should only be obtained from Russia or Holland. A bag of seed contains 28 gal., and the price varies according to quality and supply from 26*s.* to 32*s.* per bag for Russian (Riga) seed, and 27*s.* 6*d.* to 42*s.* for Dutch seed. Flax growers still incline to the belief that Russian, or as it is more commonly called Riga, seed is most suited to light soils, and Dutch to heavy loams or clays. Recent experiments have, however, demonstrated that in some years Dutch seed will produce the best crops on all classes of soils, heavy and light; whilst in other years Riga seed will produce a better crop on any soil than will Dutch. The question of the selection of seed turns therefore on quality. A good sample of Dutch seed should be of 99 per cent purity, germinate at least 97 per cent, and 1000 seeds or pickles should weigh 4·5 grm. The corresponding figures for good Riga seed are 97 per cent, 94 per cent, and 4·5 grm. respectively.

The excellence or otherwise of sowing seed from Russia or Holland depends not only upon the crop from which it was obtained, but also to a large extent on the weather which prevailed at the time of harvesting the seed. Dark-coloured and light, flat, immature pickles denote that the seed has been badly saved. The common brands of Riga seed are obtained in the western provinces of Russia, such as Courland, Livonia, and Pskov, though small quantities of good sowing seed have of late years been obtained from more easterly provinces, such as Smolensk, Yaroslav, Kostroma, and Vologda. Of the Russian seeds, Pernau Crown has on the whole given the best returns in Ireland.

Dutch growers also annually import Riga seed

for sowing. The first year's produce of such seed when grown in Holland is known as Riga Child. This may in turn be sown in Holland, and its produce is called Riga Grandchild. Dutch seed imported into Ireland for sowing is usually therefore Riga Child or Grandchild. The following example may serve to illustrate the considerations to be taken into account with regard to the purchase of one or other of these two varieties. As a general rule, it may be stated that after a good seed harvest in Russia in any one year there will be produced in the following year in Holland, if the weather is favourable, good Riga Child seed. If, however, in that, *i.e.* the second, year, only poor seed is harvested in Russia, Riga Child will be better seed than that available from Russia. Then again, in the third or following year, Riga Child will do better in Holland than the newly imported Riga seed, and in consequence the resulting Riga Grandchild will be better for importation into the United Kingdom than the Riga Child produced from poor Riga seed. It is therefore necessary for flax growers to study the seed harvest reports each year from Russia and Holland, and to buy only through reliable importers in such centres as Belfast, London, or Londonderry. Riga seed always bears a blue flower, and its produce, Riga Child and Grandchild, have also that characteristic. There is, however, also grown in the Dutch province of Friesland a white-flowered variety of flax. This has short, coarse, much branched stems, and produces an inferior crop of poor-quality fibre and a large quantity of seed. This variety is quite unsuited for growing in the United Kingdom, but has at times been exported for sowing purposes from Holland by unscrupulous merchants.

Should a season when good seed is difficult to procure follow one when good seed was plentiful, that originally intended for the previous season's sowing, *i.e.* old seed, will often give good returns. Before sowing such seed, however, it is well to test its germination, which may have become seriously impaired. This may be done by placing a few grains or pickles of the seed in moist sand in a saucer, which is then kept for a few days in a warm room.

Though formerly flax seed, as sold for sowing, contained at times the seed of flax dodder (*Cuscuta europea*), a parasitic plant living on flax exactly as does the clover dodder on clovers, this impurity has never been met with in the samples examined by the Government seed-testing station for Ireland. The dodder seed, moreover, is very much smaller than flax seed, and, being round, differs in shape, so that its removal from linseed presents no difficulty.

In Ulster, flax is generally sown towards the end of March or in April. For fibre purposes it is sown more thickly than for seed, the object being to check branching and to produce long clean plants, and thus long fibre, for it is only from the main stem that fibre is yielded in the mill. In a branched stem the fibre will break off where the branches or 'boughs' arise. In Ireland the rate of seeding per statute acre is 7 to 7½ pk. (stones) of Dutch, or 7½ to 7¾ pk. of Riga seed of the above-mentioned standard of germination, &c., poorer qualities of seed being sown at correspondingly higher rates. The seed being relatively small, lenticular in shape, and slippery, is difficult to sow. It may be sown broadcast by hand, by a seed barrow, or by means of a hand machine, the 'little wonder', known also as the fiddle, made by H. Adams, Garry, Ballymoney, Co. Antrim. This machine, which is slung over the shoulder of the operator, consists of a hopper, from which the seed is delivered on to a disk, which is made to revolve by means of a string attached to a bow, hence the name 'fiddle'. The string is passed round a drum carrying the disk, and by moving the bow the disk is rotated and the seed thereby scattered. Whether sown by hand or machine, the land should be marked off in strips, each the width of a cast—12 ft. where the fiddle machine is used—for, to ensure an even crop, regular and equal distribution of the seed is most important. After the seed is sown the land is given two strokes with a light harrow, the second at right angles to the first, and then rolled.

The after-cultivation consists in hand-weeding the crop, and if for any reason it was not possible to roll after harrowing to cover the seed, this should be done when the plants are 3 or 4 in. high, after the first weeding. The crop is weeded as may be necessary until it is some 8 in. high, and in order to disturb the soil as little as possible, the weeds should be pulled after rain has fallen. Owing to the improvement of the seed-cleaning machinery in Riga and Rotterdam, seed is now much purer than formerly, and of the small quantity of weed seeds present in sowing flax, none appear to germinate and thus cause trouble to growers.

No satisfactory machine for pulling flax has yet been devised, and, except where grown for seed only, the crop is invariably pulled by hand. If the land was marked off in flats for sowing, the supervision of the pulling is much facilitated, as each worker will pull the crop on one or more flats. It is considered to be ready for pulling for fibre purposes when it has turned a light-yellow colour, and when all the leaves from the root to about halfway up the stem have fallen. Another method of testing whether the crop is fit for pulling is to cut the seed boll across with a sharp knife. It should be pulled when the seeds in the boll are no longer milky but firm, and somewhat brown in colour. Careful observation and much experience are required in order to judge the most desirable stage at which flax should be pulled, for if taken out of the ground too early, a soft weak fibre and poor yield is the result; if allowed to become over-ripe, a dry coarse fibre, wanting in spinning quality, is produced. In wet weather, flax which has lodged may be injured at the base of the stems, and to prevent this damage to the fibre it is better under such circumstances to pull the crop, though it may not have attained the proper stage for pulling. Similarly, if in very bright sunny weather the base of the stem turns rusty or reddish-brown, owing to an attack of flax rust (*Melampsora Lini*), which results in a discoloured brittle fibre, the crop should be at once pulled, for the damage so caused by the rust will

far more than outweigh the slighter loss due to pulling at too early a stage. As a rule, flax is ready for pulling in Ireland some 100 days, say 14 weeks, after sowing.

The pulled flax is tied in sheaves or 'beets', with rush bands in Ireland, and with flax or straw bands in other countries. The sheaves are made some 8 in. in diameter, though many successful Irish and Dutch growers who ret green flax make sheaves only 4 in. in diameter. No pains should be spared to keep the flax even and straight in the beets and the root ends square. To ensure even retting, the beets should also be of regular size. When pulled, the crop may be stooked, root ends up, for a few days without damage, if dull weather prevails, but in bright sunny weather it should not remain longer than a day in the stook before being put in the retting pond, as, if heating of the straw inside the sheaves takes place, the fibre will be rendered soft and thereby seriously deteriorated.

In many parts of the Continent where seed is saved for sowing purposes, the crop is not pulled until the seed is rather more mature than at the above-mentioned stage. In these cases the straw is dried on the field, as was formerly done in Yorkshire, either in the beets or in specially constructed wooden frames. In other districts, notably in the blue steep district of Belgium, about Bruges and Lokeren, the seed bolls are removed from the green flax by a process known in this country as 'rippling'. The practice in Ulster is, however, not to ripple the flax, and recent experiments have demonstrated that in uncertain weather, such as prevails in the north of Ireland, and which adds considerably to the difficulty of properly saving seed from green flax, rippling is not remunerative, unless with a crop bearing a large amount of seed. In a drier climate, rippling might with advantage be adopted. It is done in the following manner. As the flax is pulled, the separate handfuls which form a beet are crossed diagonally, so that when the beets come to the rippler the branched ends are not entangled, but each handful may be conveniently lifted without disturbing the remainder of the beet. The 'rippling comb', consisting of a set of iron teeth about 10 in. long, is fixed across a plank supported in some convenient way, 18 in. above the ground. The two workers sit astride the plank facing one another, one on each side of the comb, and alternately strike through the comb a handful of flax. By pulling the flax towards them the seed bolls are combed off, and these then fall on to a sheet spread beneath. After being rippled, the straw is tied as before. The seed bolls should be spread on an airy loft, frequently turned to prevent heating, and, when dry, crushed by rolling. The crushed bolls are then winnowed, and the seed thus separated. Such seed, being immature, is only suitable for feeding purposes.

The fibres of the flax plant are arranged as a cylinder enclosing the woody core of the stem, to which they are attached by a mucilaginous substance. To facilitate the removal of the fibre from this core, the straw, green or dried, is allowed to ret or rot in water, and by the action of putrefactive bacteria, naturally present on the flax or in the water, the adhesive substance is decomposed. Retting ponds should be about 4 ft. deep, and so narrow that the beets may be forked into them from the two sides. Water containing iron or lime is not suitable for retting, and soft water is most desirable. It is a good practice to allow some water to collect in the pond before putting in the flax. The beets are placed in the pond in rows, root end down, in a slightly sloping position, and when the pond is filled and more water run in, the flax is weighted down by stones, so that the branches are kept below the surface of the water. When packed too tightly in the pond, the flax rets unevenly. If during the retting or fermentation the beets rise in the water, more stones should be placed on them. When once filled, no sudden flow of water should be allowed through the pond; but a very slow, steady trickle will do no harm, and may possibly be advantageous. The highest quality of flax is retted in sheeted crates anchored and sunk in the slow-flowing Lys in Belgium; and in Ireland, by retting in a large volume of water a better-coloured flax is obtained than by steeping in small ponds.

To determine when flax has been properly retted calls for great judgment. If under retted, the fibre cannot be properly separated in the scutch mill from the woody portion of the stem; and, on the other hand, if over retted, the fibre will be soft, and will break away in the mill, and a large quantity of tow will be produced. The most reliable test for determining when flax is sufficiently retted is to pull average stems from several beets in the pond, and to break each stalk across at two places about 5 in. apart. If the 5 in. of core can be readily drawn, showing that it is easily separated from the outer and surrounding cylinder or reed of fibres, the correct stage has been reached. The length of time required for retting is dependent upon the water, its temperature, and the class of straw. High temperature and coarse straw are conducive to quick retting. Under like conditions, however, flax rets more quickly in some ponds than in others. In Ulster, with water at a mean temperature of 64° F., flax is usually retted on the tenth day after being placed in the pond, or, as it is expressed, after nine nights.

When retting is completed, it is usual to run off the water from the pond. 'Flax water', as it is then known, is extremely poisonous to salmon and trout, and difficulty often arises in regard to its disposal. It possesses a most objectionable smell. Such water may be collected in a lower reserve pond and run into a stream in time of flood, or run over the land directly. Contrary, however, to an oft-expressed opinion, the manurial value of flax water is so slight as to be regarded as negligible.

When the water is run off from the pond, the beets are thrown out and stood in a heap on the bank for a few hours to drain. The flax should not, however, remain long in the heap or it will heat, and the fibre will thereby be rendered soft. The flax is now carted to a rather bare grass field, the bands untied, and the retted straw evenly spread in rows on the grass to dry. Care

should be taken to shake out the flax, for if the stalks adhere together, even drying will be prevented, and discoloured fibre will result. An occasional shower whilst the flax is spread will not prove harmful, but persistent rain may cause over retting.

The dried flax is now tied again in beets, but it should be seen that the bands are also dry. The beets are then built into large stooks or rucks, and after a week or so the flax is stacked or stored until it can be conveniently scutched.

The scutching of flax, *i.e.* the separation of the fibre, is not done by the grower, but is carried out by machinery in mills erected for the purpose. Though not strictly appertaining to farming practice, the treatment which the dried retted straw undergoes in the scutch mill may be mentioned. It is first passed in handfuls between corrugated rollers, so as to break the woody core of the stems. The rolled handfuls or 'streaks' are then held by hand over a wooden or iron stock, and beaten by wooden blades fixed on a shaft running at the rate of 200 to 250 revolutions per minute. Six or eight blades are fixed in rims on the shaft opposite each stock. The streaks of scutched flax are tied in bundles for sale to the spinners. The tow or fibre which breaks away is re-scutched, and then sold for the manufacture of coarse linen materials. The refuse, consisting of the woody core of the stems, known as shows or shives, is used for fuel in the furnaces of steam-driven mills, or by cottagers, and also for bedding cattle.

Flax growers in Ulster are usually charged for scutching one shilling per stone of scutched flax yielded, and the tow is claimed by the mill-owners. The yield of a fair crop is 4½ cwt. per statute acre, but larger yields are often obtained by good farmers or in certain seasons when the weather suits the crop.

Price varies according to quality, and largely also with demand. When the linen trade is bad, flax prices are naturally low. On the average of recent years' prices it might be estimated that 50*s*. per cwt. was paid for the better class of Irish flax, though many farmers invariably get a better price.

Many systems of so-called artificial retting of flax have been devised and patented. Some of these involve the use of pure cultures of bacteria; others of chemicals, usually alkalis, for dissolving the gums and mucilage of the flax plant. The fibre obtained by such means is dry and harsh, and does not hackle well in the spinning mills. Other methods consist in the retting of dried straw in tanks through which water of regulated temperature is allowed to circulate slowly. It has been claimed that by these methods the conditions approach to those prevailing on the famous river Lys at Courtrai; but although there has been produced by these processes a high yield of flax of good quality, colour, and strength, they have not proved remunerative owing to the large capital outlay and working expenditure necessitated.

Flax fibre is used in the linen industry for the manufacture of lawns, cambrics, damasks, sheetings, thread, nets, hollands, bagging, sails, and ropes. Linseed is used as a cattle food, and from it is also obtained linseed oil, largely used for paint manufacture and other industries.

Two other varieties of flax, *Linum grandiflorum rubrum* and *L. flavum*, which bear scarlet and yellow flowers respectively, are solely of horticultural interest. [J. H. H.]

Flax Dodder, a climbing weed which is parasitic on flax. See DODDER.

Flax Seed. See FLAX and LINSEED.

'Flax Seeds.'—These are the puparia of the Hessian Fly, and represent the second stage in the existence of the larvæ. They are small, dark-brown, and flattened in appearance, resembling flax seeds, hence their name. See CECIDOMYIA.

Flea.—The fleas, or Pulicidæ, are said to belong to the group of the blood-sucking Diptera, but they are now more generally classified under a separate group—the Aphaniptera. All forms are wingless, but the presence of small platelike structures on the prothorax of certain species seems to indicate that ancestral forms were winged. The body is laterally compressed. The thorax consists of three distinct segments, a feature which serves to differentiate the fleas from dipterous insects, in which the thoracic segments are fused together. The antennæ are small and retractile, and the mouth parts adapted for piercing and sucking. The legs, especially the last pair, are long, strong, and adapted for leaping. The female is provided with a curiously curved ovipositor, and lays her eggs or *nits* in dusty places, or in the case of the human flea on the hair follicles. The maggots which develop from these *nits* are white in colour, small and threadlike in appearance, and consist of fourteen segments, the head segment being hard and chitinous, and having a piercing appendage on the dorsal surface. The maggots develop into nymphs, which in turn give rise to the fully developed flea. The commonest species are: the House Flea (*Pulex irritans*), the Hen Flea (*Pulex gallinæ*), the Dog Flea (*Pulex serraticeps*). Sprinkling affected places with Persian powder or powdered parsley seed is effective in killing off these noxious pests. See also APHANIPTERA.

[R. H. L.]

Flea Beetles, a family of small winged beetles which includes the well-known pests Hop Flea (*Haltica concinna*), the Turnip Flea Beetle (*Phyllotreta nemorum*), and the Cabbage Flea (*Haltica oleracea*). See arts. on HALTICIDÆ and PHYLLOTRETA.

Fleece.—Fleeces vary much, in accordance with the breed of sheep, treatment, climate, and the age of the sheep. The fleece is composed of wool and hair, the wool in most breeds preponderating, though there are African breeds where the wool is sparse and short, and the hair comparatively long and suggestive of a goat's coat. It is an endeavour of the breeder of breeds with a fleece sufficiently valuable to be shorn, to breed out the hair, or at least to confine it to certain parts. Sheep in hilly and wet countries have more hair than those in drier places, because it is a function of the hair to shoot off the wet. Hair is found most on those parts which come into contact with the

ground when the animals lie down; the thighs, even in breeds where improvement has been practised for many years, will often show much hair or 'breechiness'. The character of the fleece is greatly affected by climatic conditions. During cold weather thinner wool-fibre is produced than in hot. Wool sorters make many divisions in a fleece, as many as twelve; but the ordinary divisions are the prime or mother wool from the neck and back, seconds from the tail and legs, and thirds from the breast and belly. The farmer should keep the fleece free from straw, hay, string, and other materials before and after shearing. See also arts. WOOL; SHEEP, MANAGEMENT OF. [W. J. M.]

Flesh, Chemistry of.—Animal flesh as offered for food consists almost entirely of the skeletal muscles and those of similar structure, such as the heart and the diaphragm. Non-striated or 'involuntary' muscle is consumed in the form of tripe and other preparations of the digestive canal, while the liver, pancreas, kidneys, and brain are all impressed into culinary service. Still, to the great majority of men, animal food means flesh or muscle, and it is of flesh in this sense that the present paragraphs treat.

Meat as ordinarily sold contains bone, muscle, gristle or cartilage, tendon, connective tissue, fat, and blood. Of the total weight, bones form from 20 to 25 per cent, and in young meat such as veal the proportion may run up to fully 30 per cent. This is by no means loss, as the bones contain a considerable amount of nutriment, being specially rich in fat, and if they are crushed and boiled they yield a fairly rich soup. The following table gives the analysis of the bones in an army ration of beef:—

Water	12·1
Proteids	24·5
Fat	11·0
Ash	48·6
Loss	3·8
Total	100·0

Details of the proteids—	
Digestible proteids	10·3
Peptones	1·9
Extractives	1·0
Total useful proteids	13·2
Indigestible proteids	11·3

The general composition of flesh used as food is shown in the following table (Munk):—

Constituents.	Ox.	Calf.	Pig	Horse.	Fowl.	Pike
Water	76·7	75·6	72·6	74·3	70·8	79·3
Solids	23·3	24·4	27·4	25·7	29·2	20·7
Proteids and gelatin	20·0	19·4	19·9	21·6	22·7	18·3
Fat	1·5	2·9	6·2	2·5	4·1	0·7
Carbohydrates	0·6	0·8	0·6	0·6	1·3	0·9
Salts	1·2	1·3	1·1	1·0	1·1	0·8

Roughly speaking, about three-quarters of flesh consist of water, and the proportion is higher in the case of young animals and in animals imperfectly nourished. As a foodstuff, meat is valued for its stores of proteids and fats, the latter including phosphates, potash, and iron. It is our chief source of nitrogenous food, containing weight for weight four times as much proteid as milk. In addition it is easily cooked, very easily digested and assimilated, contains a large amount of nutriment in small bulk, and carries its own condiments in the form of extractives and the special flavours developed by cooking. Its one disadvantage from the chemical standpoint is the absence of starch or other carbohydrates.

The proteids of meat fall into three classes—proteids proper, gelatins or albuminoids, and extractives. Of the total nitrogenous matter, 77·4 per cent consists of proteid insoluble in water, 10·08 of soluble proteid, and 12·52 of extractives. Of the soluble proteids, by far the greater portion is coagulable by heat; thus a sample of lean beef for beef tea gave 13·56 per cent of its total proteids in the form of proteids soluble in cold water, and of this 90·04 per cent was coagulated by heat, 8·40 appeared as albumoses, and there were traces of peptones, although both of these classes were not necessarily present in the meat originally.

When fresh muscle is washed free from blood and subjected to pressure, a fluid is squeezed out, the meat juice or muscle plasma, which coagulates like blood. This is due to the formation of *myosin*, the chief proteid of muscle, and it is the coagulation of this within the body which constitutes *rigor mortis*. Three stages may be distinguished in the process. At first the flesh is soft and alkaline, then it stiffens, and finally as the rigor passes away the flesh again softens but is now acid. In hot climates meat is generally eaten in the first and second stages, in cold climates in the third stage. The acid in question is sarcolactic acid, and it is found not only after death, but as a fatigue product within the muscle after great exertion. Normal living muscle is alkaline. Gelatin is really formed in meat by the process of cooking, at the expense of the connective tissues surrounding the muscle fibres. The gelatins resemble the true proteids in composition; they are not so nutritious, but are more digestible, and so form a favourite diet for invalids. The flesh of young animals yields more gelatin than that of old ones; according to Liebig, 1000 parts of beef yield only 6 parts of gelatin, while veal yields 50.

When flesh is digested with cold water for some time, various constituents are dissolved. These are the extractives, and they fall into

vo classes—nitrogenous and non-nitrogenous. he latter comprise fats, glycogen or animal arch, dextrose or grape sugar, inosite or muscle ıgar, and lactic acids of different types. All ıese exist in small quantities, and nothing ırther need be said about them save that after ıl visible fat has been removed from meat there ,ill remains a fair amount of fat, as revealed by n ether extract. The nitrogenous extractives re more important, and consist of creatin, creanin, xanthin, hypoxanthin, carnin and carnic :id, urea and uric acid, taurin, and inosinic :id. Only the first two are of importance, lthough American meat extract contained 1 per ent of carnin. Dealing with lean meat alone, beef-tea meat', water extraction under the ıost favourable conditions removes 6 per cent, f which 5 are organic; with the whole ration, one, &c., included, the proportions are 3·6 and ·8 respectively. It is curious that the amount f extract depends upon the method of preparaon, and this serves to explain the marked ifferences in chemical analysis between raw nd cooked meats. The nitrogenous extractives ary from 1·00 to 1·75 per cent of the total 'eight, and the non-nitrogenous from 1·40 to ·20. Speaking generally, from a quarter to third of dry (water-free) lean raw meat is ›luble in cold water; the proportion is much ıss for cooked and fat meats.

These extractives are represented by beef tea nd the numerous forms of extract of meat, ıeat juice, &c., which have been placed upon ıe market. Beef tea is a singularly correct ame; it is not a food at all, but a nerve ,imulant like tea. The real food is contained ı the discarded beef, which is supposed to have arted with its 'strength' to the solution. As matter of fact, this rejected meat is thoroughly igestible, lacking only the flavours and stimuınts of which it has been deprived. 'In brief, eef tea is poker, beef is fuel, and heat can no ıore be obtained from a poker than the body ın be nourished on ordinary extract of meat r beef tea.'

The fats which occur in meat consist of a mixıre of simple fats, almost exclusively palmitin, :earin, and olein. Each of these simple fats ıay be regarded as a compound of glycerine nd the corresponding fatty acid: thus, stearin, roperly tri-stearin, may be called stearate of glycerine or stearin glyceride. Stearin is the most solid, melting at from 53° to 66° C.; it is an excess of this fat which causes the firmness of suet. Palmitin melts at 45° C., and olein melts at −5° C.; it is thus the olein which is not only liquid itself but keeps the others in solution, and compound fats which like lard contain a large proportion of olein are soft, buttery, or even liquid. These three simple fats are mixed in different proportions in the fat of different animals. Beef fat contains a large proportion of stearin, and melts at 45° C.; mutton fat contains still more, and requires a higher temperature. Fat is found in nearly all the animal tissues, even in liquids like sweat and saliva. In visible fat, or adipose tissue, it forms 82·7 per cent of the whole, and in the marrow of bone as much as 96 per cent.

The pigments which occur in the fatty tissues partake of the same nature. They are mostly yellow or red, and are classed as lipochromes. Lecithin is a complex fat found wherever living protoplasm occurs, either animal or vegetable; and in the animal tissues it occurs chiefly in connection with the brain and nervous tissues, in yolk of egg, and in blood corpuscles. It contains nitrogen and phosphorus in addition to the carbon, hydrogen, and oxygen which constitute the true fats. Cholesterin is another fatlike substance found in protoplasm, and especially in nervous tissues; it is really an alcohol, $C_{27}H_{45}OH$, and is insoluble in water.

The inorganic constituents of muscle, represented by the 'ash' of chemical analysis, show a marked preponderance of potash and phosphorus. The total ash varies from 1 to 1·5 per cent, and the following analyses by Bunge show the details in parts per 1000:—

	(1)	(2)
K_2O	4·654	4·160
Na_2O	0·770	0·811
CaO	0·086	0·072
MgO	0·412	0·381
Fe_2O_3	0·057	—
P_2O_5	4·644	4·58
Cl	0·672	0·70
SO_3	—	0·10

Katz exhibits much the same proportion in another way, showing the maximum and minimum amounts in 1000 parts of fresh flesh from various animals:—

K	2·4 to 4·6	
Na	0·3 ,, 1·5	
Fe	0·04 ,, 0·25	
Ca	0·02 ,, 0·39	
Mg	0·18 ,, 0·37	
Cl	0·32 to 0·8	
P	1·22 ,, 2·04	from phosphates.
P	0·13 ,, 0·48	,, lecithin.
P	0·09 ,, 0·32	,, nuclein.

The most recent researches on this subject ave been made by Emmett and Grindley of llinois University, and they find that the soluble rganic phosphorus of beef is 2·3 times greater han what it is in veal; in fact, all forms of ›hosphorus are greater in beef than in veal, with ne exception, namely the insoluble phosphorus, vhich is greater in veal than in beef. Of the otal phosphorus, 75 per cent in beef, and 64 per ent in veal, is soluble in cold water—a fact of ome importance in making such extracts as oups. The soluble organic phosphorus constitutes in beef one-third, and in veal one-fourth, of the total soluble phosphorus. Lastly, the quantities and nature of these phosphorus compounds are decidedly affected by the different methods of cooking flesh.

The effects of cooking upon flesh are partly mechanical, partly chemical. The process loosens connective tissue and converts it into gelatine, separates the muscle bundles and fibres, destroys any parasites and bacteria present, if the temperature is high enough, coagulates the blood left in the flesh, and develops flavours or natural

condiments such as 'osmazone'. Although the fibres of the meat are separated and therefore rendered more easy of access to the gastric and other digestive juices, the fibres themselves are rendered more difficult of digestion. Generally speaking, cooking diminishes the digestibility of meat; from the nature of the case it cannot add to the amount of nutriment present, and it often takes away considerable quantities. The different methods of cooking fall under two categories—those which aim at extracting, and those which aim at retaining the juices of the meat. The making of beef tea or soup is a typical extracting process, and in these the destination of the exhausted meat does not enter into the problem. As the object is to extract as much as possible, the meat should be cut into small pieces so as to present a large surface to the extracting liquid, and the solvent power of the liquid, generally cold water, may be increased by adding a little vinegar and salt, as many proteids are soluble in weak saline solutions though not in ordinary water. As albumin and its allies coagulate at 73° C., the temperature of the liquid must not reach that point; if, therefore, vegetables are being used which require a higher temperature in order to soften their tissues, they must be cooked separately, either in space or time. A common method is to cook the vegetables first at a high temperature, then allow the contents to cool and add the meat, then finally the flavourings, which are apt to be dissipated by even a gentle heat.

In stewing, the process is similar, but the whole product is to be consumed, and this is the most economical method of cooking, as nothing is lost in the process. A recent German experiment gave from 1 lb. of beef and 7 oz. of veal bones a pint of strong broth or soup, which contained by weight: water, 95·2; proteids, 1·2; fat, 1·5; extractives, 1·8; and mineral matters, 0·3 per cent. Braising is stewing in an extract of animal and vegetable juices instead of water, and is generally employed for meats, like white flesh and poultry, which are somewhat insipid in themselves.

The other methods of cooking aim at retaining the juices of the meat, and they therefore operate at a high temperature to begin with, so as to coagulate the surface albumin, and thus form a continuous skin or case within which the meat is cooked in its own juice, so to say. In roasting, grilling, and baking, the necessary temperature is obtained by using radiant heat and hot gases; in steaming and boiling, water is the vehicle; while in sautéing or wet frying, hot oil is employed. Dry frying or pan broiling depends upon direct conduction of heat from the hot metal, plus a varying amount of heat derived from the fat and juices of the meat itself.

In roasting, the meat is exposed to radiant heat, from a glowing, smokeless fire, for from five to ten minutes at close quarters, so as to form a surface skin. Basting favours the formation of this, as the hot oil employed reaches every part, and subjects it to a surface temperature much higher than that of boiling water. When the skin is complete, the meat is removed and allowed to cook in its own juices; too high a temperature at this stage will burst the case, as shown in the cracking of the surface, but the continuous basting not only prevents cracking and surface charring, but imparts brownness of colour and delicacy of flavour by developing aromatic products known as 'osmazone'. Although the surface temperature is very high, the interior of a joint may not be much higher than 73° C., a temperature high enough to cook meat, but not nearly sufficient to kill parasites or bacteria. Thus in a piece of meat weighing 10 lb. the internal temperature after four hours' boiling was only 88° C., and in roasting the internal temperature often runs from 70° to 93° C., being lower with a large piece. This consideration is of great importance in connection with tinned meats, because the internal temperature in these is often not sufficient to kill bacteria of putrefaction. Thus large and small tins placed in a salt bath at a temperature much above that of boiling water showed internal temperatures of only 72° and 98° C. respectively.

Broiling, grilling, and brandering are really different forms of roasting on a small scale, and *over* instead of in front of the radiant surface. No forks should be used in handling these meats in order to avoid escape of juices. In baking, radiant heat is also used, but here the operation is conducted in a closed space, the temperature is usually too high, and the result is that several oily products are converted into unpleasant vapours, which penetrate the meat and give it a peculiar flavour. In a good modern oven there is practically no difference in flavour between a roasted joint and a baked one; all that is wanted is to prevent the formation of half-burned oil from the spluttering of gravy upon the hot plates, and this is easily done by putting the baking pan into a larger tray containing water. The loss of weight by baking is about 25 per cent, chiefly owing to expulsion of water.

Boiling also aims at the retention of meat juices, and so the temperature of the water must be as hot as possible for the first ten minutes; the addition of a little salt gives temperatures above 100° C. After the surface skin has been formed, the pot may be withdrawn from the fire so as to keep the water simmering only. The remarks already made about internal temperature apply with even greater force to boiling, as in this case the external temperature is rarely above 100° C. If boiling be carried to excess the meat is 'boiled to rags'; that is to say, the muscle fibres have all been separated by the gelatinizing of their connective tissue. It does not follow, however, that the meat is more thoroughly cooked; on the contrary, the fibres are rendered hard and indigestible to such a degree that they often pass through the bowels unchanged.

The subject of loss in cooking meat has been recently investigated by Dr. Grindley, and his results may be summarized briefly. (1) In boiling, sautéing, and pan broiling the chief loss is that of water; in roasting, both water and fat are removed. (2) The loss of substance in pan-broiling (dry frying) is very small compared with those which follow boiling, roasting, and sauté-

ing. (3) When beef was cooked in water, from 3·25 to 12·67 per cent of the nitrogenous matter, 0·60 to 37·40 per cent of the fat, and 20·04 to 67·39 per cent of the mineral matter of the original uncooked meat were found in the broth. This, of course, is not an actual loss if the broth is utilized for soup or in other ways. (4) When meat is sautéed, 2·15 per cent of the nitrogenous matters and 3·07 per cent of the mineral matters were lost in the oil employed, while the cooked meat contained *2·3 times more fat* than when raw. (5) When the meats were roasted, from 0·25 to 4·55 per cent of the nitrogenous matters, 4·53 to 57·49 per cent of the fat, and 2·47 to 27·18 per cent of the mineral matters were found in the dripping. (6) Beef which has been used for the preparation of beef tea or broth *has lost comparatively little in nutritive value*, though much of the flavouring material has been removed. (7) In the boiling of meats, other things being equal, the fatter kinds and cuts lost less water, nitrogenous and mineral matters, but more fat than the leaner samples. (8) In cooking meats by boiling, sautéing, pan broiling, and roasting, the losses increased in proportion to the degree of cooking. That is, the longer the time and the higher the temperature, the greater the loss. (9) As a rule, the larger the pieces of meat cooked by boiling and roasting, the smaller were the relative losses. (10) Different cuts of the same kind of meat behave very differently as to the amount and nature of the losses they undergo when cooked in hot water. (11) When meat is cooked in water at 80 to 85° C., placing the meat in hot or cold water at the start has little effect on the amount of material found in the broth.

In speaking of the digestibility of food, the phrase usually refers to gastric digestion only. Any experiments that have been made on this subject are open to correction, inasmuch as they imitate the actual bodily processes only in a very small degree. They lack, for instance, the continuous absorption of digested matters, the vital activities of the leucocytes and the lining cells of the digestive tract generally, as well as the sympathetic nervous action called into play by flavours and other excitants, emotional as well as physical. When a man was supplied with not more than 2 lb. of flesh per day, it was found that 97 per cent of this was digested. Raw meat is most easily digested of all, and roasted meat the most completely digested. On an average, a healthy person digests nearly all the proteid and about 95 per cent of the fat in animal flesh. The high position which flesh takes in this respect is due to the tenderness of its muscle fibre and the small proportion of fat mixed with it, and naturally there are very wide limits in digestibility, depending upon the cut of meat, the age, sex, and condition of the animal, the species and breed of the animal itself, and the method of cooking. Using an artificial imitation of stomach digestion, a rather useful result was obtained when the element of time was taken into account. After one hour, the proteids of raw meat were found more readily digested than those of cooked meat, boiled meat was better in this respect than broiled, and fried meat came out worst of all. After two hours the same differences appeared in the same order, but after longer digestion these differences mostly disappear, and after artificial digestion for twenty-four hours the digestibility of raw and cooked meats was practically the same. The digestive fluid used was 100 cc. of a solution of 1·25 grm. of pepsin in 1 litre of ·33 per cent HCl, and the process was carried on at 'blood heat', 39° to 40° C. [J. K.]

Flesh Fly. See SARCOPHAGA.

Flint, a compact mineral substance formed of silica, which does not show the definite crystals or grains known as quartz. None the less, flint may be looked on as an assemblage of very minute granules of quartz, usually with a trace of opaline or amorphous silica. *Chalcedony* is a pure type of flint, commonly with a delicately fibrous structure.

Flint cannot be scratched by a knife, has a 'conchoidal' (*i.e.* shell-like) fracture, and is usually grey or black, weathering to brown, and often with a friable white crust, also formed of silica. In the British Isles it commonly occurs in the Chalk and other limestones, notably the Carboniferous Limestone. In the latter rock it is often styled *chert.* Most flint is, in fact, a replacement of limestone by silica in bands or lumps, and unaltered shells of molluscs or sea-urchins are often found included in Cretaceous flint. Owing to the resistance of the material to agents of decay, flint gravels may gather on surfaces of decomposing limestone, often to a deleterious extent. They form loose and unpromising soils, and the comparatively large size of the stones makes them seem to 'grow' on the land as the finer material between them is washed away. Rough roads are made with flints where the only alternative is soft limestone, as in the Chalk areas of England, and broken flints are still used and rolled in on some well-constructed country roads. The best use for the larger flints is in the construction of walls and buildings, where they form, united by mortar, an indestructible material. [G. A. J. C.]

Floating Curd.—A phenomenon occurs at times, almost wholly in hot weather, in the process of coagulation of milk in cheesemaking which is technically known as 'floating curd', owing to the action of one or more of the various kinds of *micrococci*—the *Saccharomyces lactis, Tyrothrix urocephalium, Masticis cocci, Bacterium lactis aërogenes, Bacterium coli commune,* and others.

The term 'floating curd' correctly indicates the appearance of the phenomenon, inasmuch as the curd, instead of gradually sinking to the bottom of the milk vat and lying there an inert mass, becomes inflated by gas-producing ferments and rises, until it appears a little above the surface of the whey. There is a peculiar and disagreeable odour in it, and it is difficult to manage. A fine cheese cannot be made of it, especially in respect to flavour and odour. Some makers hasten to develop lactic acid to a degree greater than they would otherwise venture to do, with the object of counteracting by this ferment the mischief caused by another. But as an extreme degree of lactic acid is injurious

to the flavour, aroma, and texture of cheese, the cure is almost as bad as the malady.

Other makers cut the floating curd finely, first removing it from the whey, or the whey from it, and expose the particles freely to the air, constantly turning and mixing them about. This process mitigates the mischief more or less, but not effectually, for the inflation will occur again in the cheese. When this is the case, the cheese is in some cases broken up and passed through a curd mill, and again stirred about and exposed to the air, after which it is again formed into a cheese and put under pressure. Fortunately floating curd but rarely occurs in England; in America it was formerly not uncommon in the heat of summer. [J. P. S.]

Floating Foxtail. — This is a grass of aquatic habit found by the sides of ditches and ponds and in damp situations. It is known to botanists as *Alopecurus geniculatus*, and belongs to the same genus as Meadow Foxtail (see ALOPECURUS). It is easily distinguished from the latter by its stems, which are elbowed at the joints and decumbent when not floating, and by the glumes, which are not so closely united at the base as in Meadow Foxtail. This grass is of fair nutritive value, and is readily consumed by stock.

Floating Sweet Grass.—Like the preceding, this is a grass of aquatic habit very common about ponds, river banks, and slow streams. See GLYCERIA.

Flocculation, a term applied to the process whereby very fine silt or clay particles, whether existing in a moist condition in the soil or suspended in water, are collected into more or less coherent floccules or aggregates. Such a grouping of soil particles may be produced by many natural or artificial agencies, but particularly by the addition of even small quantities of certain soluble substances.

If some finely powdered clay be shaken up with water in a glass vessel, and then allowed to stand for some time, it will be observed that small particles of the substance remain in suspension, imparting to the water a turbidity which is capable of persisting for an indefinite period. If, however, a solution such as lime water be now added to the turbid liquid, the clay particles aggregate, and after a short time settle to the bottom of the vessel, leaving the liquid above them perfectly clear. The compound flakes produced in the manner described can be easily broken up again into their constituent parts by various mechanical means, such as puddling, boiling, or violent agitation in water. If they are allowed to dry, the cohesion between the individual grains renders the floccules of clay very stable; but aggregates of finely divided quartz or other minerals break up easily or even fall to pieces of their own weight, when deprived of the water films by which they are held together, and when no cementing substance has been left behind on the evaporation of the moisture.

Various theories have been advanced to account for the flocculation of turbid liquids; but, as these depend on the view ultimately taken of the nature of solutions and the behaviour of substances in a dissolved state, it is better to leave their discussion to works on physical chemistry. By most writers, flocculation has been regarded as an electrical phenomenon.

Many chemical substances bring about the flocculation of clay, and also of silt particles when the latter are smaller than ·02 mm. diameter. Free acids are very effective, while the majority of soluble mineral salts are more or less potent. On the other hand, ammonia, caustic alkalis, and strongly alkaline salts like carbonate of soda have the effect of diffusing fine silt and clay, of preventing their flocculation, and even of causing a dissociation of aggregates already existing. A ·02-per-cent solution of lime will lead to the speedy precipitation of suspended matter, and a chemically equivalent quantity of magnesia is about equally efficient. The precipitating power of other mineral compounds varies with the valency of the metallic ion, that is, with the amount of its electrical charge.

These principles of sedimentation are of far-reaching geological importance, as they underlie the formation of deltas, estuarine deposits, and bars at the mouths of rivers. The suspended matter carried down in enormous quantities by our great rivers, instead of drifting out to sea to be slowly deposited in mid-ocean, quickly settles on coming into contact with the salt water at the river mouths.

Of more importance, however, to the agriculturist is the part played by flocculating agencies in the modification of the structure of the soil, and the consequent effect on its fertility. An open soil structure admitting of the free movement of air and water, and of the free penetration of plant roots, a condition so necessary for profitable crop production, is only possible, at least in the stronger loams and clays, when the finer grades of soil particles form composite particles or crumbs. Any agency which breaks down these crumbs to the single-grained structure seriously interferes with the development of cultivated plants. It is, then, of some interest to the farmer to know what influence the addition of the various salts, now so extensively used in the form of artificial manures, have upon the soil structure.

As Mitscherlich (Bodenkunde, p. 151) points out, the conditions in the case of particles existing in the soil differ somewhat from those that we have considered in the case of matter suspended in water. In the former case the particles are not so free to move under the influence of electrical or other forces, and they already exist in a more or less aggregated form. It has been found, however, that fairly parallel results are obtainable in both cases from the addition of similar substances. It has been shown that the soluble manures, such as sulphate of ammonia, nitrate of soda, kainite, muriate and sulphate of potash, are all capable of gathering the finer particles of the soil into composite grains; but this granular structure only obtains as long as the added manurial substances remain in the soil. After they have been washed out or removed by growing plants, the soil shows a marked tendency to assume the single-grained structure. This tendency is particularly noticeable in a clay soil after a heavy dressing of nitrate of soda; in

this case, the puddling is, no doubt, accentuated by the production of carbonate of soda under the influence of the growing crop.

Carbonate of soda is a powerful deflocculating agent, and since it prevails in the 'black alkali' lands of arid regions, it does much harm there by its puddling action alone. After a period of rainfall, great depressions may be observed in these soils as a result of the closer packing produced through the disruption of the soil crumbs. When the soil dries again, a hard pan is formed, which resists all the ordinary methods of cultivation. Gypsum has been used with good effect to counteract this consolidating tendency of alkali lands; it converts the deleterious carbonate of soda into the comparatively harmless sulphate.

The beneficial change in texture attained by liming a clay soil is well known to every practical farmer. By an application of lime the soil is considerably loosened, the land is rendered more free to work, the movements of soil water are facilitated, and altogether the conditions are rendered more favourable for plant growth. Other sparingly soluble or insoluble lime compounds produce like results, although perhaps in a lesser degree. The amelioration of the soil texture brought about by them cannot be attributed altogether to their coagulating effect on clay; it seems to be partly due to their providing points of weakness in the soil lumps that are formed during the process of tillage. When these insoluble substances are worked up in the soil, they are admitted between the particles, and, as they are necessarily unevenly distributed amongst them, the great lumps, on drying, part more easily in the places where the lime compounds are embedded, and so crumble down to a fine condition of tilth.

Organic manures, such as farmyard manure or dried blood, also cause a loosening of stiff clays; but the action of these substances is, in a great measure, due to the fermentable matter which they contribute.

Other agencies besides the addition of chemical substances to the soil have a great influence on its physical structure. Ploughing the land in a wet condition may produce a puddling of the soil from which it may take a very long time to recover, while, on the other hand, cultivation performed at the right condition of moisture between wetness and dryness establishes a tilth most highly favourable for plant growth. Alternations of freezing and thawing are potent factors in the production of soil crumbs, but the beating of rain reduces the top layer of a soil to the single-grained structure, forming at the surface the stale crust so well known to practical agriculturists.

Various more or less permanent cements, such as ferric hydrate or carbonate of lime, form compound particles which probably act as individuals in the economy of the soil; these must be distinguished from the soil aggregates which we have been considering in the present article.

[T. H.]

Flock, the collective name used to denote a group of certain animals of the same kind. Most commonly we apply the word 'flock' to sheep or geese.

Flock Book.—This is a publication issued by a society of breeders of a particular kind of sheep. The object of such a book is to preserve the purity of the breed by the registration of all pedigreed animals, and to encourage improvements along certain specified lines. The book affords a convenient means of keeping a record of the descent of the animals entered in its pages, and forms also a guarantee of the accuracy and reliability of the pedigree. Consequently, nearly all pure-bred animals of prize-taking strains are registered, and the guarantee of their genealogy generally enhances the market value of the animals for breeding purposes. When any new breed of sheep is to be perpetuated, the establishment of a flock book is absolutely necessary if any fixity of type is to be observed; the desirable characteristics to be aimed at in breeding, and the scale of points to be awarded in the judging at shows, being decided by the society of breeders. Nearly every recognized breed has now its own flock book, and on this account the various breeds of sheep are reaching a higher and more uniform standard of excellence every year. [R. H. L.]

Flooding of Land, a practice adopted in the improvement of land by warping and irrigation. See WARPING and IRRIGATION.

Floors.—These have already been referred to under head of CONCRETE, the latter being one of the best materials for floors at the homestead. Except for the lairs in stable, byre, and pig house, Portland cement concrete is the best medium for the various ground floors at the farm steading. And we see no reason why it should not be used for the upstair floors there as well. Floors of wood are rarely used on the ground floor at the farm. They are hardly indeed suitable for a position of that sort. There they are liable to suffer from dampness; and they afford no check to rats. The upper floors, however, of the homestead are nearly everywhere of wood. The common wood floor consists of bearers or joists with their ends inserted into the walls of the building, and closely jointed boards nailed down to these bearers. To render the flooring boards stiffer in position they are 'tongued-and-grooved'—one edge has a ¼-in. or so projection along its middle line, while the other has a corresponding groove. The tongue of one board fits tight into the groove of the previously laid one, and thus the lot are made more rigid than they would be if merely butted edge to edge. The boards are usually 6 in. broad and 1⅛ in. thick; planed smooth on face. Joists 9 in. broad and 3 in. thick are required for granaries; lighter ones do for a hayloft or such like. Joists are ranked at the standard distance of 18 in. from centre to centre of the planks; at this rate 3-in. joists stand 15 in. apart face to face. The joists cross the narrow part of the building, and the boards lie at right angles to the joists. Sometimes it is expedient to support the joists by means of a stout beam running with the length of the building halfway between side walls. Red pine is the preferable material for ground floors; white pine is good enough for upper ones. See also BUILDINGS and BYRES.

[R. H.]

Floriculture. See FLOWERS, CULTIVATION OF.

Flour, in the common acceptation of the term, is ground wheat grain freed from the outer fibrous layers or bran. The wheat kernel is enclosed in three distinct coverings (bran coats), immediately below which is a single layer of large cells rich in nitrogenous matters (the aleurone layer, often wrongly termed the gluten layer). In the lower part of the kernel, opposite the rounded end, is situated the germ or embryo plant. The rest of the grain, the endosperm, is composed of cells filled with floury material rich in starch and albuminoids ('gluten'), and containing also appreciable quantities of mineral matter and other compounds. It is this material which, when isolated from the rest of the grain, constitutes flour.

The 'milling' process, or manufacture of flour, consists essentially in first freeing the grain from dirt and other impurities, then grinding it up between rotating stones or rollers, and separating the flour from the coarser materials by means of sieves and fans.

Formerly the grinding was universally effected by means of large circular slabs of stone placed horizontally, the lower one fixed and the upper one rotating about a vertical axis. The grain was fed between the stones round the revolving shaft, and driven gradually by the centrifugal force arising from the rotation to the edge of the stones, where the ground materials emerged, and by thorough sifting through fine silk gauze were separated into flour and 'tailings'. The tailings were further freed from the coarser bran particles by sifting, and then reground with a view to obtaining more flour, the processes being repeated so long as a profitable amount of flour could be extracted. In this way the wheat was separated into about 65 to 75 per cent of flour and 25 to 35 per cent of 'offal', the latter being separated roughly by sifting and fanning into bran and sharps (pollards or shorts).

The flour obtained by this process, judged by modern standards, was of poor quality, being relatively coarse in texture, rich in fine branny particles and germ, and decidedly greyish in colour. The offals, on the other hand, were of correspondingly high quality for stock-feeding purposes.

Since the middle of the 19th century the milling process has been made very much more efficient, partly by improvements in the nature and adjustment of the stones, partly by the substitution of rollers for the millstones, and partly by improvements in the arrangements for cleaning the grain and sorting out the various products obtained at different stages of the process.

The essential difference between the modern and the older processes of milling is that whereas the aim in the latter case was to obtain as much flour as possible at one grinding, the stones being therefore placed very close together, the modern miller effects the disintegration of the grain much more gradually, and obtains thereby a far greater variety of flours and offals and a higher yield of flour.

In the modern roller flour mill the wheat is first subjected to a very thorough cleaning process to remove foreign seeds, stones, pieces of iron, dirt, rust spores, hairs, &c. The cleaned grain is crushed between coarse rollers and then subjected to the milling process proper. This consists in passing the materials through a series of rollers of successively increasing fineness of surface and closeness of setting. At each stage the material issuing from the rollers is sorted out by means of sifting machines and fans into material of different grades of fineness (tailings, middlings, semolinas, and flours). The coarser portions are milled further in order to obtain more flour, the same sorting out taking place at each stage, until eventually the grain is reduced to a series of products which may be classified as follows:—

1. Flours of various qualities.
2. Germ.
3. Middlings (or pollards)—(*a*) fine sharps or seconds, (*b*) coarse sharps or thirds.
4. Brans, coarse, medium, and fine.

For further details the reader must be referred to works on milling.

A great number of different grades of flour can be obtained in the modern milling processes. The degree of grading of the flour and also of the offals varies considerably in different mills, a fact which accounts for the great variation in the character of these products from different sources.

Leaving out of account the inevitable slight loss of material (seldom more than 2 per cent), about 72 per cent of the weight of the cleaned wheat is usually obtained in the form of high-grade flours, about 3 per cent as low-grade flours, and 25 per cent as offals. The last-named consist of roughly equal proportions of bran and sharps, the former preponderating slightly.

The distribution of the different food ingredients of the wheat grain in the various milling products prepared from it is illustrated by the following analyses by Snyder (1901):—

	Water.	Albuminoids (nitrogen × 5·7).	Oil.	Carbohydrates + fibre.	Ash.	Phosphoric acid (P_2O_5).	Acidity (expressed as lactic acid).
	per cent.	per cent	per cent.	per cent.	per cent	per cent.	per cent.
Wheat grain	**8·50**	**12·65**	**2·36**	**74·69**	**1·80**	**·75**	**·18**
First patent flour	10·55	11·08	1·15	76·85	·37	·15	·08
Second ,, ...	10·49	11·14	1·20	76·75	·42	·17	·08
Straight or standard patent flour	10·54	11·99	1·61	75·36	·50	·20	·09
First clear grade	10·13	13·74	2·20	73·13	·80	·34	·12
Second ,, ...	10·08	15·03	3·77	69·37	1·75	·56	·27
'Red Dog' flour	9·17	18·98	7·00	61·37	3·48	—	·59
Shorts	8·73	14·87	6·37	65·47	4·56	—	·14
Bran	9·99	14·02	4·39	65·54	6·06	2·20	·23

The proportions of crude fibre in the various products are not shown separately in the above table. The whole wheat grain contains as a rule less than 2 per cent of fibre, most of which is in the bran and shorts. The finer flours contain only traces, whilst the brans contain 8 to 10 per cent or more.

It will be noted that the finer flours are poorer in albuminoids, oil, and ash, and correspondingly richer in carbohydrates than the coarser grades.

The roller process effects a very complete removal of the germ from the flour. This is an advantage, since the germ, though rich in oil and albuminoids and imparting a pleasant sweetness to the newly milled flour, soon begins to undergo fermentation, causing discoloration of the flour and a tendency to become rancid. By suitable heating the germ may be rendered more stable, and may then be reincorporated with the flour with excellent results (*e.g.* Hovis flour). See MILLING.

The carbohydrates of flour consist mainly (80 to 90 per cent) of starch, accompanied always by small quantities of dextrin and sugar, especially in unsound flours.

The ash is notably rich in phosphates of potassium and magnesium.

The albuminoids, according to Osborne, comprise at least four distinct substances, of which the two chief have been termed glutenin and gliadin. These two form fully 80 per cent of the total albuminoids, and together are termed the 'gluten' of the flour. They are usually present in the proportion of about 55 to 65 per cent of gliadin to 25 to 35 per cent of glutenin.

On the amount and character of the gluten depends very largely the 'strength' or capacity for producing large shapely loaves, on which the value of the flour to the baker so largely depends. The flours from British wheats are in general 'weak' in character, and hence require to be blended with a considerable proportion of foreign-grown material to give a satisfactory baking flour.

It is as yet impossible to say with certainty what are the determining factors of strength. It was formerly thought to be directly related to the proportion of gluten in the flour. The more recent investigations in France, America, and this country have, however, not produced much support for this view, but indicate rather that strength is determined possibly to some extent by the proportion of the sticky ingredient, gliadin, in the gluten, and certainly to a large extent by the physical properties acquired by the gluten under the conditions of bread-making. The interesting experiments of Professor Wood of Cambridge have led him to the conclusion that the chief factors affecting strength are (1) the amount of sugar present in the flour, together with that formed in the dough by diastatic action, and (2) the acidity and content of soluble salts of the flour, these having a marked influence on the coherence, elasticity, and water content of the gluten. The former factor will largely determine the amount of gas produced in the dough, and will therefore affect chiefly the *size* of the loaf, whilst the latter factor will exercise an influence on both size and shape.

In addition to 'strength', the colour, flavour, and notably the water-absorbing power of a sample of flour are taken into account in appraising its value. The water-absorbing power is regarded as of great importance by both miller and baker, since it not only governs the weight of bread obtainable from the sack of flour, but it also affords evidence of other qualities of the flour, especially its soundness.

Adulteration of flour is apparently not very common in this country, the chief additions met with being potato flour, ground rice, rye flour, and alum. Other adulterants occasionally met with are barley meal, bean and pea flour, and plaster of Paris. Flour from mills where the cleaning of the wheat is not very efficiently performed is liable to contain weed seeds, notably corn cockle and darnel. In bad seasons, blighted and ergotized corn have been met with. In flours that have been bleached, traces of the bleaching agent frequently remain. [C. C.]

Flour Beetle, a small brown beetle which is a veritable pest in the bakeries of Europe and America. See ECHOCERUS.

Flour Moth, a small moth with a wing expanse of about 1 in., and one of the worst pests with which the miller has to contend. See EPHESTIA.

Flower Farming. See FARMING, SYSTEMS OF.

Flower Garden. See GARDEN.

Flower Pot.—Any kind of pot which is used as a receptacle for soil in which a plant is grown is called a flower pot. The Japanese have a curious taste with respect to flower pots, some of their designs being most fantastic, and others quite works of art. The English flower pot is generally made of ordinary clay, and is more or less in the form of a truncated cone. It varies in size from that of a lady's thimble, used for baby orchids, to that of a hogshead, some of the pots in use weighing over ½ cwt. and costing about £2 each. The more porous the pot the better it is for the plant, but as porosity means softness, those that are baked hard are on the whole most economical. Flower pots are very cheap, what is known as a 5-in. pot costing about 1*s.* 6*d.* for four dozen (a cast). Other varieties of pots are made for various purposes, such as blanching seakale, rhubarb, &c. [W. W.]

Flowers, Cultivation of.—The art of gardening is largely devoted to the production of flowers for their æsthetic qualities. The love of flowers springs from the artistic sense; it is not merely because they have attractive colours, or form, or fragrance that civilized man finds pleasure and interest in growing flowers in his garden or using them for the adornment of his home or person, or as an expression of friendship or affection; they are as it were a part of his scheme of life, just as music and art are. It is for the purpose of satisfying this sense of beauty in flowers that their artificial cultivation has become an important industry as well as a delightful art. Not only has almost every corner of the world been ransacked in the search for

flowers, but in most civilized countries now the breeding of improved forms and races is largely practised. Nearly every one of the popular garden flowers have been developed from comparatively inferior prototypes; for example, our chrysanthemums, roses, dahlias, carnations, hyacinths, cyclamens, cinerarias, cannas, lilacs, begonias, delphiniums, rhododendrons, and pelargoniums, to mention only a few, are, as known in gardens, exclusively the outcome of the breeder's art. In some cases improved races have been evolved by selection, and it is surprising how much progress can be made by this means alone. Garden races which have been developed from a single species by selection are cinerarias, the Chinese primulas, the chrysanthemums, the decussate phloxes, the zonal pelargoniums, and many others. There is, of course, nothing more remarkable in this than in the races of apples, pears, potatoes, and grapes, which are the descendants of a single species in each case. It is natural for all plants to vary when reproduced from seeds, and by seizing upon variations of a particular character in each successive generation the gardener does not take long to make considerable change in the direction he wishes to go. The desire for novelty in flowers as in many other things has to be satisfied, and therefore the changes brought about by the cultivator's art, whilst they meet with general favour, are not always an improvement in a truly artistic sense. The big dahlia, the mop-like chrysanthemum, the double begonia, and even many of the roses, are monstrosities in every sense. Still, there is a fashion in flowers as in hats, and even in music, and the present popularity of the flower garden, the gay greenhouse, the bouquet, and the floral decorations in use in rooms is entirely wholesome. For this reason the art of cultivating flowers should not be neglected in schools. It is more attractive to the young than the cultivation of vegetables or fruits, and probably has a more refining influence, as it is more likely to awaken a love of natural objects than the best example of cabbage or turnip would ever do.

The flowers that find most favour in gardens are not exactly the same in different countries. Daffodils, for instance, are very popular in British gardens, but they find little favour with the French; orchids are as peculiarly a British fancy as horses and dogs; auriculas also are favourites in England and nowhere else. Generally, however, the flowers that are in fashion are the same everywhere, so far, that is, as the conditions favour their cultivation. A list of the flowers that rank among the most popular at the present time would occupy more space than can be afforded. Among those that require glasshouse conditions are acacias, azaleas, begonias, bouvardias, calceolarias, camellias, chrysanthemums, cyclamens, fuchsias, gardenias, gloxinias, hippeastrums, lapagerias, nerines, orchids, pelargoniums, passifloras, phyllocactuses, poinsettias, primulas, rhododendrons, richardias, streptocarpuses, and for winter effect, roses. Flowers that may be grown in the open air are more numerous now than ever they were. Thanks to the development of a taste for out-of-door gardening, large numbers of beautiful-flowered plants have been brought into prominence. It is only necessary to name some of the most popular here. These are aconitums, anemones, antirrhinums, asters, campanulas, carnations, crocuses, daffodils, dahlias, delphiniums, forget-me-nots, foxgloves, fritillarias, gentians, gladioluses, helianthemums, hellebores, hemerocallises, hyacinths, irises, kniphofias, liliums, lobelias, lupines, marigolds, mignonette, nymphæas, œnotheras, pæonies, pansies, pentstemons, phloxes, poppies, primulas, rudbeckias, stocks, sweet peas, snowdrops, tulips, verbenas, veronicas, violets, wallflowers, and zinnias. Shrubs that are grown for their floral effect include roses, rhododendrons, diervillas, spiræas, lilacs, berberis, cistuses, wistarias, deutzias, ceanothuses, cytisuses, daphnes, escallonias, forsythias, hydrangeas, hypericums, jasminums, loniceras, magnolias, olearias, moutan pæonies, philadelphuses, tecomas, veronicas, viburnums, and yuccas. Among the trees there are the horse chestnuts, catalpas, laburnums, and numerous species of Pyrus and Prunus.

The cultivation of flowers for profit is dealt with in 'Flower Farming', under the heading FARMING, SYSTEMS OF, and the particular treatment required by each kind of garden flower is given under their respective names. [W. W.]

Flukes, or **Trematodes,** a class of parasitic flatworms, usually leaflike in shape, including the well-known liver fluke (*Distomum hepaticum*) of the sheep. Some are external parasites, others occur in the internal organs of their host; some complete their life-history in one animal — Monogenea (and these are usually ectoparasitic), others require two hosts — Digenea (and these are endoparasitic). With their parasitic life may be associated the presence of attaching suckers (occasionally with hooks), the absence of cilia on the surface of the adults, the possession of a thick external 'cuticle', and the rarity of sense organs. The food canal is usually forked, often much branched, and always ends blindly. There is a hermaphrodite and usually complex reproductive system, and in many cases the animals are self-impregnating.

Among the important flukes from the agriculturist's point of view, the following may be noted: the liver fluke (which see) of the sheep, occurring occasionally in horse, deer, goat, pig, rabbit, man, &c.; *Distomum pulmonale* in the lungs of dogs and cats; *D. magnum* in deer and sheep (in Italy and North America); *Bilharzia crassa* in the cattle of Egypt, Sicily, and some parts of India. There are many different kinds of flukes in birds, *e.g. Monostomum flavum*, which passes its young stage in a common water snail (Planorbis) and its adult life in ducks. In fishes, also, there are many flukes, and the formation of some kinds of pearls is primarily due to the irritation caused by the presence of a microscopic larval fluke in the skin of the bivalve. See also LIVER FLUKE. [J. A. T.]

Fluorides.—These are compounds of the element fluorine, which is closely related to chlorine. Sodium fluoride, NaF, is very closely related chemically to common salt, sodium chloride. The fluorides have strong antiseptic

and preservative properties, and they have been patented for use as antiseptics under the name 'Salufer'. Those which have been chiefly used for antiseptic and preservative purposes are sodium fluoride, sodium bifluoride, potassium fluoride, ammonium fluoride, aluminium fluoride, and sodium silicofluoride. They are colourless and odourless substances, with only slightly poisonous properties towards higher animals, but as they kill or prevent the growth of many noxious micro-organisms, they form useful antiseptics and disinfectants. They are also used in brewing to destroy harmful organisms, and are useful in preparing pure cultures of yeast. It is probably in brewing that fluorides are most largely made use of. Fluorides are also used to a limited extent as preservatives for foods. For instance, sodium fluoride has been proposed as a substitute for sodium chloride, and boric acid as a preservative for butter. A very small percentage of sodium fluoride has a stronger preservative action than a much greater amount of sodium chloride. Fluorides have also been used as preservatives for milk, and tinned and other meats. It is claimed that as fluorides are not poisonous they are permissible for this purpose. There is some evidence, however, to show that while fluorides do not in small doses produce death, their action may be more or less injurious, and that therefore their use in foods should not be permitted. [J. H.]

Flushing.—In order to have the ewes in good thriving condition, and so to ensure a larger proportion of twin lambs, it is the common practice with sheep-farmers to run the ewes on to better 'keep'—such as clover aftermath—a fortnight or three weeks prior to tupping time. This practice is known as 'flushing'. See SHEEP, BREEDING AND MANAGEMENT OF.

Flux.—Flux is an old term for any abnormal flow of fluid from the body, and particularly any sanguineous or morbid discharge from any of the organs or natural outlets. It is—or was, we should rather say—applied to vaginal as well as bowel discharges, and particularly to dysentery (which see). See BLOODY FLUX. [H. L.]

Fly.—Strictly speaking, the term 'fly' should only be applied to those insects which belong to group Diptera or true flies. Thus the designations Hessian Fly (*Cecidomyia destructor*), Crane Fly (*Tipula*), Gad Fly (*Tabanus*), House Fly (*Musca*), Cabbage Fly (*Anthomyia*), Frit Fly (*Oscinus*), Bot Flies (*Œstridæ*), Sheep Maggot Fly (*Lucilia sericata*), are all scientifically correct, as all these are dipterous insects. But the Turnip Fly (*Haltica nemorum*) belongs to the family of the Beetles, the Sawflies to the Hymenoptera, the Green fly to the Hemiptera, and in fact all insects capable of flight are popularly, though incorrectly, referred to as flies. [R. H. L.]

Flycatcher. — Flycatchers (Muscicapidæ) derive their name from their peculiar habit of feeding. They take up a situation on a branch of a tree or other prominent position, and whenever a fly happens to come near they dash at it, catch it upon the wing, frequently with an audible snap of the beak, and return to their previous point of vantage, or some other close by. Two species of Flycatcher are found in Great Britain. Of these the Spotted Flycatcher (*Muscicapa grisola*) is far the commoner. It is only a summer migrant in this country, and about the latest to arrive of all the spring visitors, often not appearing till well on in May. Its appearance, brown above and grey with brownish streaks below, scarcely justifies the epithet of 'spotted', except in the young, which are spotted all over. It is found throughout Great Britain, being very common in the south, but becoming rarer in the north. The other British species is the Pied Flycatcher (*Muscicapa atricapilla*).

Spotted Flycatcher (*Muscicapa grisola*)

This bird is far less common than the Spotted Flycatcher. It is found in greatest abundance in the English lake district, and is more common in the north and west of England than in the south. In Scotland it is rather rare. It arrives towards the end of April, and is much more conspicuous in appearance than the commoner species, on account of the contrast of black and white in its plumage, from which it derives its name. Neither Flycatcher has much of a song, and both depart for warmer countries in the autumn. [H. S. R. E.]

Flying Stock.—A 'flying stock', as it is called, is a stock not regularly and continuously kept on a farm, but frequently changed. Thus on ordinary sheep-farms, flocks of ewes are commonly kept from one to four or five years old, but on some farms draft ewes are purchased every autumn, and sold off in the succeeding summer and a fresh stock purchased. In town dairies and on dairy farms adjacent to towns it is a frequent practice to purchase cows just at the calving and to sell them off again as soon as they become dry, instead of keeping them on for a number of years, as is more usually done. In both these cases the farm is said to keep a 'flying stock'. [R. P. W.]

Foal, the offspring of the horse.

Foaling. See PARTURITION.

Foal Teeth. See AGE OF ANIMALS and TEETH.

Fodder.—In an agricultural sense 'fodder'

is a term generally applied to the foods given to stock more with the intention of supplying bulk to them than because of their intrinsic feeding properties. *Every feeder of stock knows full well that the first requisite in feeding animals is, to use a common expression, to 'fill their bellies';* and, until this is done, the concentrated and expensive foods given them will not be employed to the best purpose, but will be used up in doing the work which commoner and cheaper materials could do better. It is only when an animal gets his 'fill' that he will begin to lay on flesh. Hence bulky foods, such as straw, hay, or green stuff, are given to serve this necessary purpose. Not that these materials are devoid of feeding value, and indeed they vary considerably among themselves in respect of value, but it is not for this purpose primarily that fodder is employed.

Fodder may be dry, as in the case of straw and hay, or it may be wet and green, as when *grass, lucerne, sainfoin, clover, trifolium, mustard, tares or other crops are cut green, or when silage is used. Of straw crops, those principally* used are wheat straw, and oat straw, and occasionally barley straw, bean straw, and pea straw. The two last-mentioned are much the most nitrogenous, but do not come generally into use; barley straw also is not a favourite with feeders, owing to its roughness. Oat straw is the favourite food with practical men, and wheat straw follows next in value. The following analyses represent the comparative composition of these different straws:—

	Oat Straw.	Wheat Straw	Barley Straw.	Pea Straw.	Bean Straw.
Moisture	14·3	14·3	14·2	13·6	18·4
Fat (ether extract)	2·0	1·3	1·5	1·6	1·1
Albuminoids	3·5	3·0	3·2	9·0	8·1
Amides, &c.	·5		·3		
Soluble carbohydrates	37·1	38·0	37·5	33·7	31·0
Woody fibre	38·6	38·8	39·2	35·5	36·0
Mineral matter (ash)	4 0	4·6	4·1	6·6	5·4
	100·0	100·0	100·0	100·0	100·0
Nitrogen	·64	·48	·56	1·44	1·29

The usual way of feeding straw is to pass it through a chaff-cutting machine, and either to place it, when chaffed, in the manger, or else to mix it up with sliced or pulped roots. A good plan is to mix the roots overnight with the chaff, sprinkling a little water over the mass if it be too dry, then turning over with a shovel and leaving in a heap. A gentle fermentation sets up which makes the straw more palatable. Another plan, when it is desired to get the stock to eat straw plentifully, or when straw or hay is not of very good quality, is to pour over it some molasses diluted with water, and, after mixing the whole, to leave it to stand in a heap overnight. Similarly, with inferior or damaged hay, a little spice thrown over it will make it more acceptable to stock. In such ways as these, stock will often be got to take their bulky food more readily.

Straw represents the extreme stage of a corn crop, and, as such, consists largely of fibre, with little or no starch, this latter having been transferred to the grain. It is also rich in silica, though there is no ground for the belief that the supply of silicates to the plant is necessary for the 'stiffening' of the straw. Potash and lime are abundant in the straw of leguminous crops. Straw is essentially a food for bullocks and cows, and is not given to either horses, sheep, or pigs.

Hay, as a rule, is either meadow hay or clover hay, but lucerne, sainfoin, and trifolium hay are also used in parts of the country where these crops are grown. Lucerne and sainfoin hay are the most nitrogenous, and then come trifolium and clover, meadow hay being the least nitrogenous.

The following are analyses of meadow hay and clover hay:—

	Meadow Hay.		Clover Hay.
Moisture	17·90	......	18·60
Fat (ether extract)	2·20	......	2·50
Albuminoids ...	6·05	......	10·50
Amides, &c. ...	1·20	......	2·00
Soluble carbohydrates	43·93	......	33·83
Woody fibre ...	22·62	......	25·65
Mineral matter (ash)	6·10	......	6·92
	100·00		100·00
Nitrogen	1·35		2·01

Hay will vary in quality not only according to the land on which it is grown, and the season, but also according to the period at which it is cut, that cut earlier being the more nutritious, though there will be less bulk than if left longer uncut. Hay containing much clover is more nitrogenous than that with little or no clover in it. The conditions under which the hay has been gathered in, and under which it is stacked, exercise, however, the chief part in determining its quality, and, mainly, its selling value. Hay secured in good condition and nicely matured in the rick will often fetch a good price in the market, whilst the same grass, if made into hay under bad weather conditions, requires not only very careful handling in the rick, to prevent 'heating' and 'firing', but may be unsaleable and have to be consumed on the holding.

Hay is generally given cut into chaff, but a little long hay given to bullocks occasionally makes an agreeable change. Clover hay is always chaffed; it is preferable to meadow hay for sheep, and is much better utilized by them.

Lucerne and sainfoin both make valuable hay,

though these crops are confined mostly to certain parts of the country. If left to get too dry, the leaves are apt to crumble into dust and to leave little more than the stalks. This is seen to be the case with the *alfalfa* (lucerne) imported from the Argentine and elsewhere. Trifolium (crimson clover) is more usually cut green, but is sometimes made into hay, and can be cut up into chaff for horses. If left to get overripe, the woolly seed-heads have been known to cause injury to sheep, owing to the tendency of the woolly portions to collect into balls which look like lumps of hair, and to block the intestines.

When crops are cut green and given to stock as food this is called 'green fodder'. Grass is but little used in this way, but clover, lucerne, and sainfoin may be fed off on the land by sheep, or may be cut green and given to horses, bullocks, or milking cows. Rye is another crop that may be cut green and fed. Trifolium also is cut green and given to horses. Mustard, rape, and tares (vetches) are generally fed off by sheep on the land. In the case of milking cows the main purpose is the supply of a succulent food. Silage is used with much the same object: it may be made of grass, clover, or of a variety of different crops, such as maize, tares, oats cut green, rye, &c. The practice of making silage has much gone out of vogue of late, though in parts where the weather can never be depended upon to make hay properly, it may still be usefully employed. Also where roots are scarce and a regular supply of succulent food is required—as when a large herd of milking cows is kept—the making of silage has a distinct advantage. Rough grass from waysides, &c., can be made into useful silage when it could not be made into hay. Speaking generally, while it is better to have silage than bad hay, it will be found more profitable to make hay whenever it is possible to secure this in fair condition.

[J. A. V.]

Fodder Flea. See Gastroidea.

Fœtal Membranes.—The ovum is surrounded by membranes, and these form cavities containing fluids, the cavity next to the ovum being called the *amniotic* cavity. This cavity contains a straw-coloured liquid known as the *liquor amnii*, which analysis proves to contain such substances as sugar, lactic acid, mucin, keratin, albumin, urea, &c. During the later phases of gestation the fluid becomes of a reddish tint and emits a most peculiar odour, well known to those having had to do with the delivery of foals, &c., the delivery of which it facilitates.

The next membrane is known as the *allantois*, and this forms a cavity containing the allantoic fluid, said to be derived from the urine of the fœtus *in utero*. This membrane springs from the body of the ovum at a point that subsequently becomes the navel or umbilicus.

Both these membranes are surrounded by the *chorion* or *placenta*, developed for the nourishment and purification of the blood of the fœtus, the blood supply being kept up between mother and fœtus through the medium of the navel cord, which consists of the umbilical arteries and vein and other structures.

This cord is ruptured at birth, or else tied off. In the mare and sow the chorion (placenta) is attached to the lining of the womb by villi all over its surface, and the term *diffuse placenta* is applied to such; but in cattle it is attached by tufts of villi known as cotyledons or *roses*, from which it has to separate during cleansing. The afterbirth or cleansing (placenta) should come away within forty-eight hours after the calf, foal, &c., is born; if not, it ought to be removed. In the dog and cat the placenta is zonary, and the young are born enveloped in the membrane. See Parturition. [F. T. B.]

Fog is a term applied by farmers in Scotland to the various mosses which grow so plentifully on poor pastures. It is popularly supposed that the growth of the fog checks the growth of the grass, and some go so far as to maintain that if the fog were but removed, the poor pasture would thereby become rich The facts of the case give little support to such a view. If, for example, we examine an old moss-grown wall, we find here and there tufts of grass growing and thriving. In this case the important point to notice is that the grass grows on the spots where soil has accumulated, and the moss only where the soil is quite thin. Indeed the grass plant from its very construction needs a certain depth of actively working soil to form a suitable habitat for its roots, and a much greater depth than a moss plant. Now on foggy pastures we find associated with the fog only the small-leaved grasses with the shallowest roots, and though all the fog were removed by hand it is incredible that the poor pasture would become rich thereby. Applications of lime, and various manures, drainage, indeed any treatment which deepens the region of actively working soil, is found in practice to improve the grass and to diminish the fog. The presence of fog should accordingly be regarded as a sign that the soil is inactive to the proper depth; the fog does not choke out the grass, but indicates that the land itself is out of order, and that our efforts should be directed to improvement of the soil itself, and to the maintenance of such improvement by seeding to a large extent with lasting and deep-rooted plants, such as Cocksfoot, Timothy, Tall Oat, Tall Fescue, &c., according to the character of the land. For eradicating fog on pastures, the following methods have proved successful: (1) Thorough drainage of the land: (2) chain-harrowing the pastures in winter or early spring; (3) the application of lime, or a dressing of basic slag and kainit; (4) the application of 5 cwt. common salt per acre. The last two methods have proved very effective. When the soil is made favourable for grass-growing by good management, the fog disappears. [A. N. M'A.]

Foggage. See Aftermath.

Foissen, or **Fuzzion,** a provincial term used to denote the natural juice or sap of plants.

Fold and Folding.—Folding or penning sheep in comparatively small areas is practised in most districts, though far more so in some than in others, but most so where large numbers of sheep are maintained on arable land. The objects of folding are to confine the sheep on a limited area, so that they clear up a portion

of the crop in a field without injuring other portions, and thus daily have a piece of fresh keep to consume; to ensure that each portion of the field receives its due quantity of manure; to allow the land, as soon as it is cleared, to be ploughed up; to keep the sheep in safe enclosure; to manure land by the droppings of sheep resulting from food collected on other land, as on down or hill pasturage, and so improve the arable land; to compress light soils so as to give them a firmer texture. Folding involves extra labour on account of the moving of the fold daily, but the expense is well warranted by the beneficial results. Close folding on arable land is most practised in the districts where Down breeds of sheep are kept, as except when ranging on downs they are mainly kept in the close fold, even in summer, when they are feeding off clovers, sainfoin, vetches, cabbages, rape, and other crops of arable land. Also, when taken from their native districts to be fattened out on arable land in winter, they are practically always in the close fold. Fewer of the long-wool breeds are fattened out before they are a year old, and as they are for a considerable portion of the year ranging on grass pasturage, they spend less time in the fold. Hill sheep come down from the hills when keep is short and there is risk of snow, to go into the turnip fold, but know nothing of it in summer. The fold is made of temporary fencing. At one time, light flitting hurdles were almost universally used, but during recent years there has been a great increase in the use of wire netting and cord netting, as they require fewer stakes to uphold them, are lighter to move from field to field and from fold to fold, and are economical so long as they are properly taken care of. Hurdles are not expensive where the wood is obtainable on the farm, and are more secure. In most districts the ordinary flaked or slatted hurdle is used, but in the south-western counties wattled hurdles are almost exclusively used. A fold on turnips is generally a chain square to hold 200 sheep on a fair crop; but it is always wise to allow a previous pen to remain as a fall back for the sheep, and in wet weather it may be advisable to allow more. When sheep are placed on fallow land to manure it in night folds, from three to five sheep per hurdle square are allowed for, according to district.

[W. J. M.]

Fold Yard.—Fold yards embrace the various kinds of open yards used for holding cattle. They are known by different names, such as lodges, field barn yards, courts, &c., according to district; and the enclosing fence may be of any material, as is most convenient to the locality. One of the most common errors in yards is that of placing them in holes where drainage is difficult; or they are allowed to become hollowed out so that water is held up in them. Animals will not thrive properly if they have to lie in the wet, as they lose so much heat by doing it. Fold yards should not be too large, and a portion facing the sun, sufficient to allow the animals to lie under cover, should be covered in and be provided with a feeding manger. Racks and portable cribs may be placed in any convenient positions. The sides should be boarded or otherwise made to prevent draughts; the bottom should be made firm, so as to retain liquid manure. The water from roofs should not be allowed to run in; if outside water is kept out, and the yards kept well littered, it is only in the wettest districts that the rainfall will float the dung. Open yards are admittedly extravagant in litter, and where rainfall is excessive more area should be covered in. To allow liquid to run out of a yard is wasteful, unless there are efficient means to distribute it on the land. Yards should be made so that the animals' droppings are absorbed and retained by the litter. With dry lair, store cattle of all kinds thrive well in yards, and cows are much healthier when they are only taken to byres to be milked.

[W. J. M.]

Food and Drugs Acts.—With a view to preventing the adulteration of food and drugs, various Acts have been passed, which are known collectively as the Sale of Food and Drugs Acts, 1875 to 1907.

The term 'food' includes every article used for food or drink by man other than drugs or water, and any article which ordinarily enters into or is used in the composition or preparation of human food, and also includes flavouring matters and condiments. The term 'drug' includes medicine for internal or external use.

Anyone who mixes, colours, stains, or powders, or orders or permits any other person to mix, colour, stain, or powder, any article of food with any ingredient or material so as to render the article injurious to health, with intent that the same be sold in that state, or anyone who sells an article so adulterated, is guilty of an offence. The offence may be committed by someone who himself mixes or sells the article, or it may be committed if, in the ordinary course of business, an employer permit his servant so to contravene the section. If, however, a person has sold an article so mixed, he can escape conviction if he satisfies the Court that he was ignorant of the article being so mixed, and could not, with reasonable diligence, have obtained that knowledge. In order to a conviction under this prohibition, it is necessary to show that the mixing would have the effect of rendering the article injurious to health.

Anyone who mixes, colours, &c., any drug so as to affect injuriously its quality or potency commits an offence. It is not necessary that the drug be rendered injurious to health, but merely that it is deteriorated in quality; but absence of knowledge where same could not with reasonable diligence have been obtained is a good defence.

The sale of articles of food and of drugs not of the nature, substance, and quality of the article demanded by the purchaser, to the prejudice of the purchaser, is an offence under the Acts. It is under this section that the majority of prosecutions take place.

1. PARTIES LIABLE TO PROSECUTION.—Both the master, though not the actual seller, and also the servant who actually does sell the article may be liable. Usually, however, it is the

master who is prosecuted, and he is liable to be convicted for an offence committed by his servant or even by strangers over whom he has no control. Thus, where water had been unlawfully added during transit, without the knowledge of the seller or his servants, to milk which had been despatched unadulterated, the seller was held to have committed an offence against the Acts.

2. Knowledge or Ignorance of Seller.—From what has been said, it will be evident that the knowledge or ignorance of the adulteration will not affect the offence, since a person who retails an article in the same state as he buys it, and without knowledge of its having been tampered with, may yet have committed an offence under the Act.

3. *Purchaser must be Prejudiced.—That is to say, the purchaser must get an article inferior to that demanded and paid for.* Consequently, if the adulteration be duly intimated at the time of the sale, the purchaser cannot be prejudiced, if he nevertheless purchase an article inferior to or different from that which he had originally intended to purchase.

4. Extent of Deterioration.—It is not necessary to prove that the article sold is deficient in all three respects—of nature, substance, or quality. All that is necessary is, that it be deficient in one of them. Thus, where an article has a recognized standard of composition or quality and an inferior article is sold, an offence is committed.

The milk prosecutions which are unfortunately so common throughout the country are mostly taken under the section of the Act which has just been referred to. In virtue of the Food and Drugs Act of 1899 the Board of Agriculture was authorized to make regulations determining what deficiency in any of the normal constituents of genuine milk, cream, butter, and cheese, or what additions of extraneous matter or proportion of water thereto, should raise a presumption under the Acts that, until the contrary was proved, such milk, &c., was not genuine or was injurious to health. In exercise of the powers thereby conferred, the Board in 1901 issued regulations relative to the sale of milk which fixed standards for milk and also for skimmed or separated milks. According to these standards, where milk (other than skimmed, separated, or condensed milk) contains less than 3 per cent of milk fat or less than 8·5 per cent of milk solids other than milk fat, it shall be presumed until the contrary is proved that the milk is not genuine, the presumption being either that milk fat or milk solids have been abstracted, or that water has been added. Where skimmed or separated milk (other than condensed milk) contains less than 9 per cent of milk solids, a similar presumption is raised.

Now it will be observed that the mere fact that the milk contains less than the standard percentage of milk fat or milk solids does not *per se* secure a conviction, but it raises a presumption against the seller that the milk is not genuine, and unless he succeed in proving the contrary a conviction must follow. That is to say, the onus lies on the seller to prove the milk genuine. There have been a large number of decisions on this question in the various courts throughout the country, and no general rule can be deduced from them, since the circumstances of each case must govern the decision. Speaking generally, however, it may be said that if it can be proved that the milk has not been tampered with in any way, and has been sold as it left the cows, no conviction should follow. Thus where new milk was sold which contained only 2·81 per cent of fat, it was proved that the cows from which the milk had been obtained had not been milked for fourteen hours before the time when the milk in question was got, and it was proved that the small percentage of fat was due to the long period which had elapsed since the previous milking, and that the milk had not been adulterated in any way. In these circumstances it was held that unless the quantity of fat or other substance absent was so large as to point to an unusual condition of things, there was no room for a conviction. But, as already pointed out, the sale of an inferior article, if the purchaser knew that there were various grades at different prices, is not an offence, unless the purchaser demanded and paid for a higher quality than he actually received.

By the Butter and Margarine Act of 1907 the limit of moisture in factory butter and margarine is fixed at 16 per cent, while in milk-blended butter it is fixed at 24 per cent. The importation of butter containing more than 16 per cent of water, or of margarine containing more than 16 per cent of water or more than 10 per cent of butter fat, or the importation of milk-blended butter containing more than 24 per cent of water, constitutes an offence against the Acts.

Where milk or cream is sold in the streets, either from a vehicle or from a can or other receptacle, the seller must have his name and address conspicuously inscribed on such vehicle or receptacle. It may in certain cases be necessary to have the name and address inscribed on both the vehicle and the receptacle, for it has been decided that where a cart was left standing at the top of a street, and sales were made from a can carried from door to door, it was not sufficient that the name and address were on the cart, but that in order to comply with the Acts they must be on the can also.

Every tin or receptacle containing condensed, separated, or skimmed milk must bear a label, clearly visible to the purchaser, on which the words 'machine-skimmed milk' or 'skimmed milk', as the case may require, are printed in large and legible type. This refers only to condensed milk, and it has been questioned whether it applies to other than imported condensed milk. Where the tin, though properly labelled, is covered with an outside wrapper on which no label appears, it is open to question if the requirements of the section have been complied with.

5. Exceptions.—It is, however, provided that no offence shall be committed under the section in the following cases: (*a*) Where any non-injurious ingredient has been added to the food or drug in order to produce or prepare

it as an article of commerce in a state fit for carriage and consumption, and not fraudulently to increase the bulk, weight, or measure of the article, or to conceal the inferior quality thereof. It is a question of fact for the Court to decide whether the addition has been made fraudulently, but the onus of proof is on the accused. That is to say, it is for him to prove it was not made fraudulently. If, however, it be held that the addition has been made fraudulently, it is no defence to show that the article was labelled as a mixture. (*b*) Where the drug or food is a proprietary medicine or the subject of a patent, and is supplied in the state required by the specification of the patent; and (*c*) where the food or drug is unavoidably mixed with some extraneous matter in the course of preparation. Where butter was found to contain 21½ per cent of water it was held that this was not in itself sufficient to a conviction, but that it must be shown that the water was not unavoidably added in the course of preparation. So when buttermilk was found to contain 30 per cent of added water it was held on appeal that as buttermilk could not be made without water it was not an article different in quality, nature, or substance from what was demanded, and no conviction could follow. But when butter was after manufacture blended with milk, and it was urged in defence to a prosecution that no offence could be committed, since by the Acts butter is defined as being made exclusively from milk or cream or both, it was held that the addition of milk was made fraudulently, and a conviction followed.

6. Defence to Prosecution.—There are practically only two defences to a prosecution against the sale of goods not of the proper nature, substance, or quality, and these are either notice to the purchaser, or sale under warranty.

(*a*) *Notice to the Purchaser.*—In the case of the sale of an article of food or drug mixed with any matter or ingredient not injurious to health, and not intended fraudulently to increase the bulk, weight, or measure, or conceal the inferior quality of the article, no offence is committed if at the time of delivering the article the seller supply to the purchaser a notice, by a label distinctly and legibly written or printed, to the effect that it is mixed. As already pointed out, if a person at the time of sale intimate to the purchaser that the article he has purchased is mixed, there is a good defence on the ground that the person so purchasing is not prejudiced, and the Act goes on to give an express defence by the handing of a label. But it must be borne in mind that even although the mixture is labelled, this will not protect the retailer if as a matter of fact it is proved that the mixture was done with fraudulent intent. The label must be distinctly and legibly written or printed, and it will not be held to be so if the notice of mixture is obscured by any other matter on the label. In the case of margarine or margarine cheese, however, the wrapper must not have any other printed matter on it. It is not necessary on the label to state more than that the article is mixed; percentages of the ingredients need not be given. Further, it is not necessary for *the seller to call the purchaser's attention expressly to the label, if as a matter of fact it is distinctly written or printed, even although the print be small. In the case of articles from which a part has been abstracted, due notice of the alteration must be given, and if this is done it is a good defence to the seller.* As to what amounts to disclosure of the alteration it is a little difficult to lay down any general rule, but it does not follow that a label will in this case be sufficient to enable the seller to escape conviction, although as a rule it would be so.

(*b*) *Warranty.*—If the party selling the article prove to the satisfaction of the Court that he purchased the article in question as the same in nature, substance, and quality as that demanded of him by the purchaser, and that he got a written warranty to that effect; that he had no reason to believe the article was otherwise, and that he sold it in the same state as when he purchased it, he shall not be liable to conviction. It is to be observed, however, that this defence is not available to the person who mixes food with ingredients injurious to health, or with any ingredients injurious to their quality or potency, or to the retailer of these articles. Nor is it available to anyone who has abstracted part of an article of food so as to affect its quality, substance, or nature, nor to the retailer thereof. Moreover, unless the defendant has, within seven days after service of the summons, sent to the purchaser a copy of the warranty, with a written notice that he intends to rely upon it, it shall not be available as a defence. This defence can be pleaded either by the party who purchased the article under a warranty or by his servant, provided the latter, however, proves that he had no reason to believe the article was otherwise than that demanded. It is also available to a party to whom the benefit of the original contract for the supply of milk has been assigned, provided there is sufficient connection in writing between the consignment and the warranty. The warranty cannot be verbal, but it is sufficient if it be printed and signed by the party supplying the article, and it should be dated. When by the contract the delivery is spread over a period of time, as to deliver 1000 gal. of milk weekly, it is advisable that each delivery should be accompanied with a specific warranty, for although the tendency of the Courts has been towards a more liberal interpretation of the statute, the decisions have been conflicting. Thus in one case, when the contract was to deliver '86 gal. of good and pure milk' daily for six months, it was held that to satisfy the Acts a written warranty must accompany each delivery. On the other hand, in a more recent case it was held that there need not be anything on the warranty to show its connection with the particular delivery if the connection be sufficiently proved by evidence. A similar decision was given by the King's Bench Division in a recently decided case, where it was held that a warranty contained in a contract for a twelve months' delivery was sufficiently connected with each consignment of milk during the period of the contract.

Provision is made for the appointment and

duties of analysts, and the proceedings which *they require to take to obtain samples and analyses for the purposes of the Act. Power is given either to the purchaser of an article of food, or to any medical officer of health, inspector of nuisances, police constable, &c., to* obtain a sample of a food or drug to be submitted for analysis. In the case of articles other than milk, it is provided that the party purchasing the article with a view to analysis must *notify* to the seller or his agent his intention to have the same analysed by the public analyst, and must divide the same into three parts, each of which shall be fastened up, one of which shall be delivered to the seller or his agent, another retained for comparison, and the third submitted to an analyst. In the case of milk, any officer, inspector, or constable may obtain a sample at the place of delivery, and in this case, and also in the case of margarine or margarine cheese forwarded by public conveyance, the person taking the sample shall forward by registered parcel or otherwise a portion of the sample, marked and sealed or fastened up, to the consignor, if his name and address appear on the can or package containing the article sampled. It has been decided that in the case of milk, margarine, or margarine cheese, &c., the provision for the division of the sample into three parts does not apply. Anyone refusing to sell an article to an officer, inspector, or constable, in exchange for the price for the quantity which he shall require for the purposes of analysis, commits an offence under the Acts. In any prosecution which takes place, the certificate of the analyst is prima facie evidence for the prosecution, but the analyst may be called and examined if required. There is a right of appeal from the Inferior Courts to the next General or Quarter Sessions in England, or to the High Court of Justiciary in Scotland.

The sale of margarine and margarine cheese has been made the subject of special legislation. Margarine means any article of food, whether mixed with butter or not, which resembles butter and is not milk-blended butter. Margarine cheese means any substance prepared in imitation of cheese which contains fat not derived from milk. All parties dealing in margarine or margarine cheese must see that every package containing such article is marked 'Margarine' or 'Margarine Cheese' on the top, bottom, and sides, in capital printed letters not less than three-quarters of an inch square; the brand or mark must be on the package itself, and not merely on a label or ticket attached thereto. Everyone selling such articles by retail must deliver the goods to the purchaser in a paper wrapper with the word 'Margarine' or 'Margarine Cheese' printed thereon in capital letters **not less than half an inch long. Such wrapper must** not have any other printed matter on it, **not even the name and address of the seller. Every manufactory of margarine or margarine cheese, or the premises of any wholesale dealer therein, must be registered with the local authority. Further, the occupier of any such manufactory must keep a register showing the quantity and destination of each consignment of such articles. It is unlawful to manufacture, sell, expose for sale, or import any margarine** *the fat of which contains more than 10 per cent of butter fat. This clause is a little peculiar, inasmuch as it fixes not a minimum standard of* quality but a maximum.

Under the latest series of Food and Drugs Acts, additional provisions have been made against the importation of agricultural or other produce which was not sufficiently marked. An importer of margarine, margarine cheese, or condensed, separated, or skimmed milk, except in packages or receptacles conspicuously labelled, or adulterated or impoverished milk, or cream, or any adulterated or impoverished articles of food, which are not conspicuously marked with a name or description indicating that the articles have been so treated, is guilty of an offence against the Acts.

By the Public Health (Regulations as to Food) Act, 1907, power is conferred on the Local Government Board to make regulations for the purpose of preventing danger to the public health from the importation, preparation, storage, and distribution of articles of food or drink (other than drugs or water), and two sets of Regulations have recently been issued, viz.: 'The Public Health (First Series: Unsound Food) Regulations, 1908', and 'The Public Health (Foreign Meat) Regulations, 1908'. Copies of these Regulations, together with an explanatory circular letter, can be obtained from Messrs. Wyman & Sons, Ltd., Fetter Lane, London, E.C.

[D. B.]

Food-preparing Machines.—Food-preparing machines include those which are required to render foods more suitable for the several kinds of stock on the farm, such as chaff-cutters to cut hay and straw; root slicers and pulpers to reduce large roots to sections suitable to be fed with or without chaff; cake breakers to crush hard cakes into pieces convenient for animals to digest; grinding and crushing mills to grind corn to a meal, or merely to crack or grittle it; steaming apparatus to moisten and soften chaff, and to drive off mould from hay, and so render it palatable and digestible; and various small utensils, such as the swill tub for receiving dairy waste, and to allow meal and other foods to soak; bone mills for grinding green bones for poultry; potato and root washers to remove dirt from roots; and aspirators or fans for clearing dust from chaff. [W. J. M.]

Foods, their Nature and Functions.—Every animal, and every cell of an animal's body, throughout its life is performing work, and therefore requires a continual new supply of energy to continue its life's work. In practically every case this energy is presented to it in the form of chemical energy, and the materials supplying this, form the food of the animal and, in detail, of each cell of the organism. When studying the different kinds of food that an animal's tissues can utilize as a source of chemical energy, it is found that they all belong to one or other of a very limited number of complex chemical groups. These are the groups of the proteins (including flesh and the nitrogenous part of cereals), fats, and carbohydrates (starches

and sugars). All these substances, it must be noticed, originate from, and only originate from, living organisms, either vegetable or animal. They are all complex carbon compounds, and the substances of one group, that of the proteins, contain nitrogen and sulphur, and at times phosphorus and iron. Amongst other materials essential for the maintenance of life, although they do not act as suppliers of chemical energy, must be mentioned mineral salts and water. The salts, which enter largely into the composition of the tissues, are usually found in sufficient quantities in the protein foodstuffs, being obtained originally from the soil through the agency of the plants. Water is essential, not only because it enters largely into the composition of the different parts of the organism, but because without it there could be no circulation, and therefore no provision for the carrying of foodstuffs to the cells and of waste products from them.

In considering the nature and utilization of the food of an animal, we have to study in the first place the transformations to which that food is subjected as a preliminary to its absorption into an animal's body. This study embraces the details connected with digestion. In the second place we have to consider the form in which the absorbed food is presented to the different cells of the body. This underlies the general problem of assimilation.

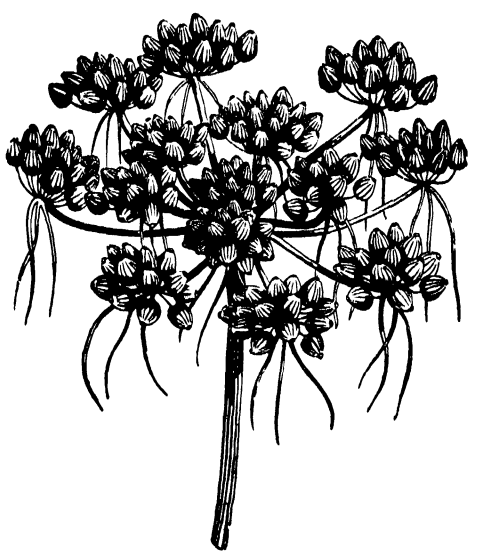
In studying digestion it is found almost without exception that the foodstuffs are not taken in a form fit for immediate absorption. They have therefore to be prepared by splitting them into molecules of a smaller size, from which the cells of the body can build them up into the requisite materials for each cell. Thus starch, which we may take as the most typical variety of carbohydrate food, is first converted into sugar, in which form it is absorbed and carried round to the tissues, and a protein is changed to the soluble substance peptone, or even broken down into much simpler compounds, the amino acids. This cleavage of the foodstuffs is effected by the agency of ferments, and the general nature of the process is one of hydrolysis. It is very important to note that in this cleavage very little chemical energy is lost, a point of obvious importance in the conversion of the food into a form in which it is directly utilizable.

The different foods, according to the various sources from which they are derived, show many chemical differences. The most important point to note here is the relative ease with which they are hydrolysed by the digestive ferments. Thus animal proteins are as a rule more readily hydrolysed, and therefore more readily digested, than vegetable proteins. Or again, among the carbohydrates there are many varieties of celluloses showing marked differences in their resistance to hydrolysis. In a carnivorous animal there is no ferment provided for the digestion of cellulose, whereas in most herbivora such is present. Even among herbivora marked differences can be observed in their power of digesting this very important and widely distributed foodstuff, so that, in considering the food that should be provided for an animal, it is essential to know how far the particular constituents can be hydrolysed, *i.e.* digested.

When considering the second part of the problem, viz. the feeding of the individual cells of an animal's tissues, attention will be at once drawn to variations in the needs of the cell, not only as to quantity, but also as to quality, according to the degree of activity of the cell, or even to the nature of the activity. But it is very notable that the cells are capable of adapting themselves in a very elastic manner to unavoidable variations in the nature of the food, for some particular type of food may be directly assimilable and immediately utilizable as the source of energy for the cell, and yet if that particular form of food or chemical energy cannot be obtained in sufficient means, the cell can still utilize other forms of foodstuff, though it may mean a preliminary chemical transformation before it is utilizable.

Lastly, in considering foods we have to remember that these may be gained by the animal in very unequal amounts at different times or seasons of the year, and hence the animal has developed the power of storing foodstuffs until they may be wanted. As types of such a capacity we may mention the deposition of fat and the storage of glycogen in the liver during the time that an excessive supply of carbohydrate is available. See also NUTRITION. [T. G. B.]

Fool's Parsley (*Æthusa Cynapium.* The name is from the Greek *aithein*, to burn, referring



Fool's Parsley in Fruit

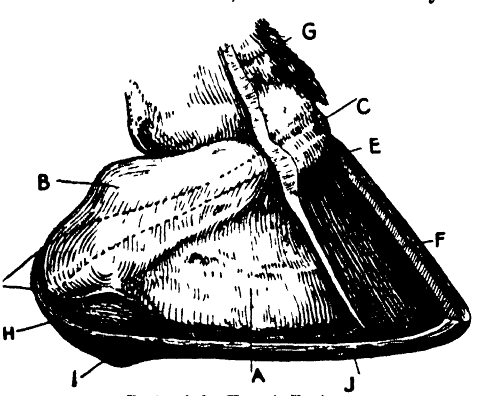
to the poisonous properties, and *kunos apion*, dog's parsley). This is a poisonous umbelliferous plant common in fields and gardens, having the appearance and size of garden parsley, but a much darker green colour. It is a bald annual with a tapering whitish root. The leaves are much cut into narrow divisions, and emit a heavy unpleasant odour when bruised. The stem is round, slightly furrowed, and about 1 ft. high.

:he flowers are white, in small compound umbels, ,nd are remarkable for having three long pen- lulous narrow leaves hanging down on one side f each partial umbel of the inflorescence. By his mark the plant may be distinguished at all imes from the other British umbellifera. The ipe fruit, commonly called seed, has ten sharp road ribs, with acute angular interstices.

Fool's Parsley grows wild in gardens, by way- ides, in shady lanes, and elsewhere, and is a ommon annual weed in cornfields. It is chiefly emarkable on account of its poisonous quality, hich causes it to produce dangerous or even ital consequences when mistaken for parsley. ortunately distinction is easy; the odour is isagreeable, the leaves never curl, and each artial umbel has three long pendulous bract aves as shown in the figure. [J. L.] [A. N. M'A.]

Foot (measure) is the unit of length, and is efined as the distance between two fixed marks ı a bar of platinum (at a temperature of 62° F.) ept in the office of the Exchequer at West- inster. See WEIGHTS AND MEASURES.

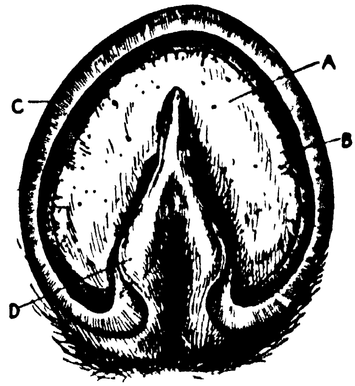
Foot, Diseases of.—The old adage 'no ot no horse' has lost nothing of its force to orse users, and no subject has received more tention from veterinarians. By the foot we ean here the popular acceptation of the word; ot that of the comparative anatomist, which nbraces the lower portions of the limbs. Dis- ases of the feet, therefore, are considered only applying to the hoof, and the structures within ie horny box and below the long pastern bone, ie short pastern bone should not be included, ut being partly within the hoof, and sharing ı some of its troubles, some latitude may be



Parts of the Horse's Foot

A, Os pedis. B, Lateral cartilage. C, Peripole. D, Peri- plic or Coronary band E, Coronary cushion F, Sensitive minæ, or fleshy leaves. G, Section of skin. H, Fleshy og. I, Horny frog. J, Horny sole.

llowed us in the present connection, for con- enience of treatment. The horse's foot, which as been described as a section of a truncated one, is outwardly composed of horn of vary- ig density. The portion visible when the nimal is standing is called the crust; with eflections at the heels forming the bars, to be en only when the foot is lifted, and between those bars the frog; and on either side, the sole. The horny parts are attached by sensitive or soft ones within, hence we have the laminæ attach- ing the crust; the fleshy or sensitive frog united to the horny frog; and a sensitive sole held in union with the horny sole by papillæ, in very much the same manner as the frog, but of dif- ferent density. If we include the short pastern



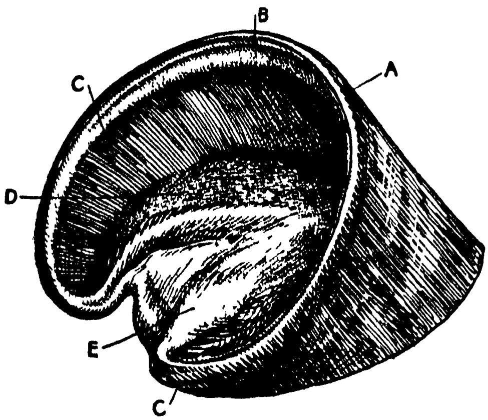
Under Surface of the Coffin bone, showing its Position within the Hoof

A, Os pedis. B, Sensitive and insensitive laminæ C, Wall of hoof. D, Horny frog.

bone, there are three bones and two joints within the hoof: namely, the os pedis or coffin bone, the navicular or shuttle bone, and the coronal. Car- tilages of elongation are attached to the wings of the pedal bone, and are known as the lateral cartilages. Tendons are attached to or have their insertion into the pedal bone; those at the back passing under the navicular or shuttle bone, and forming altogether what is known as the navicular joint. The other joint is formed be- tween the short pastern and pedal bone. The foot, which from the outside appears to be a solid block, is on the contrary a very vascular body, being intersected with bloodvessels, which not only ramify through the soft tissues, but through many foramina or tunnels in the bones. When we consider its complicated yet beautiful mechanism, we need feel no surprise that it is subject to many disorders, some affecting one structure and some another, and those of the circulatory system involving the whole. Begin- ning from the outside, where the hoof grows down from the coronary band, we may have sandcrack or seedy toe, brittle feet or false quarter, treads and frostbites, and a peculiar inflammation of the coronet itself called coro- nitis, resulting in defective horn production. The sole is subject to canker, and the frog to thrush. Between the bars, corns are met with, and the skin covering the heel is liable to chaps, cracks, and ulceration, as well as grease. Within, and commencing from the upper and lateral portions, there may be ringbone of the coronal bone, sidebone or ossification of the lateral car- tilages, and splitting or fracture of these bones; navicular disease, affecting the little shuttle bone as well as its connections, and acute or chronic

inflammation of the velvety covering or investment of the pedal bone, and known as laminitis or fever in the feet. Besides these diseases there are many foot lamenesses due to the necessity of shoeing, and not a few to the bad methods and careless manner of treating the foot; pricks from misdirected nails, from sharp flints on the road, and other injuries being of common occurrence. Cattle, sheep, and swine, with divided hoofs, have the parts anatomically arranged in the same manner, but the inner side of the claw or digit is straighter. The diseases to which they are subject are in common (save that working oxen only run shoeing risks), and they have troubles peculiar to their species, as foul of the foot in cattle, and foot rot in sheep. All the diseases and accidents to the feet above referred to will be found separately dealt with under the different letters of the alphabet. The care of the feet is a very important department of veterinary hygiene, as will be understood by the reader who has noted the rather formidable list of diseases and injuries enumerated. See also next art. [H. L.]

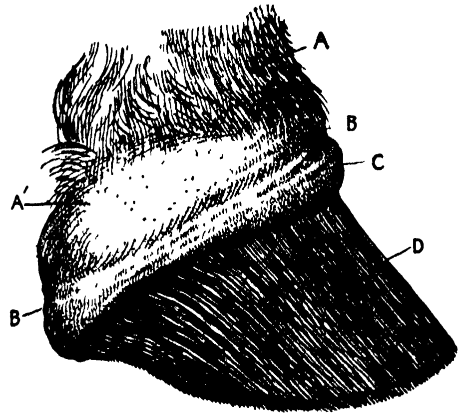
Foot of the Horse, Anatomy of.—The foot of the horse is divisible into three distinct portions, namely: (1) An outer or horny covering for protective purposes, spoken of as the 'insensitive' foot, which encloses (2) the inner or soft structures, namely (*a*) bloodvessels, (*b*) nerves, (*c*) fleshy tissue, (*d*) cartilage or gristle, and in contradistinction to the first-named portion is designated the 'sensitive' tissue of the foot, and is moulded upon the bones of the last-named. The following are the bone formations which enter into the third division of the foot. The 'coffin'



The Wall of the Horse's Foot: Hoof showing Insensitive Laminæ, &c.

A, Peripolic horn-band. B, Coronary groove. C, Insensitive laminæ. D, Horny sole. E, Horny frog.

or 'pedal' bone is a dense bone, studded on its surface with numerous minute openings for the passage of bloodvessels. The right and left arteries of the foot form within the bone a 'sinus' (the semilunar sinus). The lower surface of the bone is vaulted, and when in fresh condition is covered with a soft, velvety tissue, and moulded upon the inner surface of the horny sole. At the back of the coffin bone is a small shuttle-shaped bone, known as the *os naviculare*. There is a *bursa*, or lubricating sheath, between the two, and it is this part which is commonly the seat of a malady called navicular disease. A horse thus affected is spoken of as a 'grog', and from the lameness he is characterized as 'groggy'. The coffin bone articulates with a short square



The Sensitive Foot: Side View

A, Skin. A', Skin devoid of hairs. B, Peripolic band. C, Coronary cushion. D, Sensitive laminæ

one, known as *os coronæ*, which is also embedded in the hoof. The upper end of this bone articulates with the lower end of the *os suffraginis*, and this in turn with the lower end of the large 'metacarpal' and the sesamoids. The coffin bone has backward prolongations on either side. These are the wings, and each wing carries a flexible plate of hyaline cartilage, known as the lateral cartilages, which are commonly the seat of disease in cart horses called *sidebone*, this being a calcification (or ossification as it is termed) of the lateral cartilages. The foot has a rich supply of blood, whilst the veins are devoid of valves; consequently the blood can circulate with greater freedom throughout the foot. There is a band encircling the top of the hoof. This is the *coronary* band, and from its papillæ the wall of the hoof is formed. This latter has an upper and a lower border, likewise a 'toe' and 'quarters'. The horn is thinnest at the quarters. There are numerous leaf-like structures on the inner side of the wall. These are the *insensitive laminæ*, and they are dovetailed into the fleshy or *sensitive laminæ* on the wall of the pedal bone, but in 'founder' separation often occurs, with the result that the pedal bone drops out of its place, pushing the horny sole in front of it. The horny sole is concave, and at its juncture with the wall there is a white line. The sole is divided into the 'toe', 'quarters', 'heels', and 'bars', these last named being really inflexions of the wall, and lie on the outer side of the elastic 'frog', which in turn is moulded on the sensitive 'frog'. In the ox, sheep, pig, and goat the hoof is cloven, the cleft being spoken of as the 'interdigital space'. [F. T. B.]

Foot-and-Mouth Disease (*Aphthæ epi-*

otiæ). — Introduced into these islands from ıe continent of Europe in 1839, foot-and-mouth isease has caused the loss of millions of pounds erling. The stamping-out system was finally ıccessful, and we have been practically free om the malady for some years, although isoted cases have had to be dealt with and quickly ıppressed by the prompt action of the Board f Agriculture. The last outbreak, which ocurred in Scotland, was traced to imported hay. ike other infectious diseases, it is believed to e due to a specific organism, but the most painsaking investigations have hitherto failed to lentify it. The infective material, whatever it nay be, is chiefly in the vesicles which characterze it, and the disease follows the lines of traffic. he average period of incubation in cattle, from he entrance into the system to the first symptoms, s three to six days, and its duration varies from day or two in slight cases to a week or two in he more serious. Age and condition are factors nfluencing the period of invasion, the degree of llness, and duration of the disease; the species f animal also influences the period of incubaion. Swine are most quickly influenced, twentyour to forty-eight hours on an average, and heep twenty-four hours to six days. The popuar name is more descriptive than the generality f terms employed in connection with animal liseases, but the mouth symptoms are generally ıbsent in sheep, goats, and swine. In cattle there is a rise of 1 to 3 degrees of temperature, with loss of appetite and diminished milk secretion in cows; the mouth is kept closed and the cud is temporarily lost, then slight salivation or frothing of saliva bubbles at the mouth; then follow little yellowish-white vesicles or bladders no bigger than a hempseed at first, but quickly growing; often attaining to the size of a crown piece. The front part of the upper jaw where there are no teeth is a favourite site for them, and also the edges and lower portion of the tongue and lining of the cheeks (buccal membrane). The contents of the vesicles pass from a limpid to a turbid fluid, then break and leave very red inflamed surfaces denuded of epithelium. If not rapidly repaired, foul-smelling ulcers follow. The foot symptoms more commonly follow on the vesicular eruption in the mouth, although lameness may be first discovered. Red and painful swelling of the coronet and between the digits appears. The same processes follow in the feet as described in the mouth. Serious complications sometimes result, and the bones suffer. It is not important that we should follow these or suggest any treatment, as all civilized peoples now seek to suppress the disease by slaughter or isolation, and it is chiefly desirable that stockowners should be acquainted with the prominent symptoms above related, in order that suspicions aroused may be acted upon and expert advice at once called in. [H. L.]

Footrot in Sheep. — The name 'footrot' is usually applied to a disease in the feet of sheep, less frequently to a somewhat similar condition which is met with in cattle, the latter being more generally known as 'foul-in-the-foot'. Foot-rot is characterized by acute inflammation of certain structures of the foot in sheep, causing great pain, and frequently attended by suppuration, perverted growth of the horny structures of the foot, and in very bad cases even loss of the claws. When cases are neglected for a long period there may be infection with the germs of necrosis, in which case even the whole foot may be lost. This disease occurs to a greater or less extent wherever sheep-raising is carried on, but is most commonly met with in low-lying districts, sheep on dry uplands being usually either untroubled by this malady, or where it is present it is less virulent in its nature and more amenable to treatment than when it occurs on damp pastures.

Symptoms. — When footrot appears in a flock of sheep, one or more will be noticed to be lame, and as the cases become more advanced the affected animals will adopt the kneeling posture while grazing, this being especially the case where both fore feet are affected. In very severe cases the affected sheep will evince a tendency to lie continuously, and if the hind feet alone have been attacked the animal will drag itself on its belly. Examination of the diseased foot will show, in the early stages of the disease, signs of inflammation, beginning most usually between the digits (commonly known as the claws), from which point, as later examinations will show, it gradually extends outwards on both sides, being accompanied by heat, pain, swelling of the coronet, suppuration, and separation of the horn from the soft structures lying beneath, the chief seat of the disease, however, usually being on the inside of the claw. It would sometimes appear as if the attack commenced at the sole of the foot, but such cases are usually due to deformity of the hoof, such as uneven growth of horn, or to penetration of sand or other irritant substances. As the deeper structures of the foot become involved, it will be noticed that the character of the horn of the foot becomes changed, that of the sole frequently taking on a spongy appearance, in some cases being apparently overgrown with fungoid prominences and generally exuding a fœtid discharge, the foot becoming deformed on account of the unequal growth of the horn, and in many cases wartlike growths appearing between the claws.

Cause. — Footrot is due to a micro-organism, the infection being conveyed by contaminated pastures (Brown), the infective material being active when brought in contact with the skin between the claws, or when introduced into the system by inoculation, and possibly when taken in by the mouth from contaminated pastures, but the latter has not been proved. It is no longer held that 'footrot' can be produced by keeping sheep on undrained moist soils or on wet and rotten litter or manure, but such conditions undoubtedly predispose sheep to this disease. Inflammation of these parts, followed by suppuration, and some other of the phenomena usually associated with footrot, certainly does occur as a result of such causes as injuries by coarse grass, by blocking of the peculiar glands between the claws of sheep, and by climatic changes; but the resulting sores offer a convenient means of access to germs, so that it is safer for flockowners to treat all cases as infectious, especially as it is not

possible to distinguish between the symptoms of this non-contagious affection and the true footrot.

Treatment.—Affected sheep, if not in too large numbers, should be removed from the pastures to a dry yard or shed; but where this is not practicable the flock should be put upon dry uplands, everything possible being done to keep the affected parts dry. The unaffected sheep should be subjected to frequent examinations when once the disease has shown itself in a flock, and directly moisture is noticed on the skin between the claws, treatment should be commenced on the lines laid down below. When the affection has not progressed far and is superficial, but the number affected is large, it is found that great benefit results from allowing the animals to stand for an hour at a time in a covered shed or yard, on the floor of which is spread a thin layer of lime which has been slaked some days previously, and which, acting as an astringent, aids the healing process and hardens the horny covering of the foot.

Where flocks are very large, and individual treatment difficult, good results are frequently obtained by causing the animals to stand in shallow troughs in which some antiseptic fluid has been placed; and by the judicious use of hurdles placed on each side of a long trough sunk into the ground it is possible to keep a continuous stream of sheep slowly passing along through such a trough, the solution, which covers the pasterns, being frequently renewed, and the treatment repeated at least twice a week. For this purpose the usual preparations for 'dipping' may be used, such preparations, if manufactured by a firm of repute, having the advantage that there is less likelihood of error than there would be in cases where the flockowner mixed for himself solutions of arsenic, corrosive sublimate, carbolic acid, and such like poisonous substances. A solution of sulphate of copper, 1 lb. to 20 gals. of water, may be used, but it will be well to prepare the solution some days before using, and to the mixture should be added 1 lb. of washing soda dissolved in 1 gal. of boiling water. When individual attention is necessary it will be advisable with a sharp knife carefully to remove all diseased or overgrown horn, and when the latter is undermined with pus, proper vent for drainage must be obtained. After thorough cleansing a dressing should be applied, such as a preparation of carbolic acid in glycerine, 5 per cent. A mixture of iodoform and boric acid is very efficacious in mild cases, but the cost is prohibitive for large flocks. An old and favourite dressing among shepherds consists of sulphate of copper combined with turpentine and lard, the proportions being: sulphate of copper 1 oz., turpentine 1 oz., lard ½ lb.

One of the advantages of the use of sulphate of copper is that it acts as an astringent, and restrains the formation of excessive granulations, generally known as 'proud flesh', and for the same purpose alum, tincture of iron, and other substances are used with good effect; but such substances as butyr of antimony, tartar emetic, and other strong caustics are frequently used by ignorant persons to a dangerous extent, causing much needless suffering to the animals so treated.

In serious cases, where the deeper structures of the foot have become involved, healing is hindered by the movement of the claws, in which case it is advisable thoroughly to cleanse the affected foot, and after dressing it with a suitable preparation, to insert between the digits or claws pledgets of tow previously soaked in the same preparation, the latter being retained in position by a bandage, which will also restrain the movement of the digits. As a dressing may be used any antiseptic in proper strength, *e.g.*: (1) carbolic acid in glycerine, strength 5 per cent; (2) sulphate of copper 3 dr., carbonate of sodium 3 dr., water 1 pt.; (3) oil of tar 4 oz., rape oil 6 oz.; (4) chloride of zinc 1 dr., glycerine 1 oz.

Prevention of Footrot. — It cannot be too strongly impressed that this disease is indirectly contagious, and that therefore precautions should be taken when fresh sheep are being introduced into a flock. Wherever possible, freshly purchased animals should be kept apart from the flock for twenty to thirty days, as Brown states that the contagium may remain in the system of a sheep for twenty days without any indication of disease appearing on the skin between the claws. All cases of lameness arising from sore feet should be looked upon with suspicion, and at once isolated and treated on the lines previously indicated, a careful watch being kept on other members of the flock. Since undrained, moist soils and unsanitary folds or sheds predispose to this disease, it is obvious that selection of suitable pasture and attendance to hygiene are of great importance. Drainage of the land, application of lime, and cultivation of the soil will lessen the losses from this as from so many other diseases. [F. C. M.]

Forage Crops.—Forage or fodder crops are those grown exclusively for their production of leaf and stem suitable for the feeding of farm live stock. Dried fodder, of greater or less value for cattle feeding, is incidentally obtained in large quantities from the growth of the corn crops, and especially the oat; but as the primary purpose of their cultivation is the production of edible seeds or grains, they are not included in the class of fodder crops, except in those special cases where they are not allowed to ripen their seeds, and are cut down in an immature state to supply food for stock. Rye and barley grown as catch crops for this purpose are then properly included in the class of forage crops. On the other hand, a crop like kohl-rabi, which is grown for its enlarged stem, and a crop like the cabbage, which is grown for its great yield of leaves, are both comprised under the name of 'root' crops rather than of 'forage' crops, because the methods of their cultivation, and the position assigned to them in rotations of cropping, ally them more closely to the root crops proper, such as the turnip and the mangel, than to forage crops such as vetch and trifolium. In accordance with this definition, forage crops ought also to embrace all the grasses, clovers, and other plants which are grown for the production either of hay or pas-

ture; but the fodder crops proper are not more distinguished from the root crops by their different methods of agricultural treatment than they are from hay and pasture, and hence the plants that constitute pastures, though also grown entirely for their produce of stem and leaf, are always relegated to an entirely separate and very important division of agricultural plants. The following list, arranged in the order of their botanical classification, comprises all the crops of importance at present cultivated in Britain, and commonly comprised under the designation of forage crops.

Gramineæ: Rye (grown as a catch crop), Barley (grown as a catch crop), Winter Oats (grown as a catch crop), Italian Rye Grass (grown for green cutting).

Cruciferæ: Rape, Mustard.

Leguminosæ: Vetch or Tare, Sainfoin, Lucerne, Trifolium, Trefoil, Lupins, Gorse or Whin.

In addition to these crops, all of which are in regular and more or less extensive cultivation in Britain, mention may be made of the Prickly Comfrey (*Symphytum asperrimum*), which occupies some small areas in various parts of the kingdom; also the Maize or Indian Corn (*Zea Mays*), which has been tried on a small scale in the south of England, and which constitutes a fodder crop of importance on the continents of Europe, Asia, and America; and the Chicory (*Cichorium Intybus*), which is cultivated as a forage crop in France, Italy, and other countries. For particulars of the special characteristics and methods of all the crops named, the reader is referred to the separate articles on each.

The importance of forage crops in British agriculture is much greater in the southern than in the northern parts of Britain. They are most largely grown there as catch crops, for which the climate of the south of England gives advantages that are denied to the north; but to some extent all over the country the decline in corn growing and the increased attention devoted to stock-rearing has tended to cause a steady extension of the area devoted to the cultivation of forage crops. The advantages attending the growth of these crops are by no means inconsiderable. Most of them are leguminous plants, which have the valuable property of enriching the soil in nitrogen and rendering it more productive. These leguminous crops, as well as other forage crops, such as rape, are deep-rooting plants, and they therefore open up the subsoil and add organic matter to it in their decay, while at the same time they bring up and enrich the surface with minerals taken from the subsoil. Most of the forage crops also, like vetches and rape, are thick-growing crops which cover the ground closely, and thus choke out and smother weeds, while, whether they be consumed on the ground or cut green for removal from the fields, growing weeds are also cut down with them and prevented from ripening their seeds. Moreover, their growth tends to fertilize rather than to impoverish the land, as the greater part of the mineral matter and nitrogen in them is restored to the soil in manure, and only a small portion, perhaps on an average not exceeding 5 per cent, is retained in the bodies of the animals consuming them. Hence in the case especially of the leguminous plants the growth of forage crops has a tendency rather to raise than to lower the condition and productiveness of a farm.

The chief drawback which stands in the way of the more extensive cultivation of forage crops is the limited period during which they are suitable for consumption. Most of these crops are not adapted for being made into hay, and they are often grown at a season of the year when haymaking is hardly practicable. Their utilization in the green state is therefore imperative. But in the green state they are only at the period of maximum production for a very short time. If stock be put on them too soon, only a partial yield of the crop is obtained; if too late, the crop has become fibrous, less nutritious, less palatable, and less readily eaten.

Successional sowing in patches is not a convenient practice, nor does it usually ensure a sufficient continuance of the period of maximum production. In the adoption of the method of preserving crops by ensiling them, there seems to be a possible escape from this difficulty; but ensilage has so far not successfully established itself as a general practice in this country.

See also arts. ENSILAGE and CATCH CROPPING.

[R. P. W.]

Force.—The term 'force' as used in mechanics means any cause which changes or tends to change the state of rest or of uniform motion in a straight line of a body. This definition is in accordance with Newton's first law of motion, which asserts that: 'Every body will continue in its state of rest, or of uniform motion in a straight line, except in so far as it is compelled by impressed forces to change that state'. If a weight be suspended from a spring balance, for example, the attraction of gravity will tend to move the weight downwards and the pull of the spring will equally tend to move it upwards. Each of these actions, therefore, is a force, and as the forces are equal and oppositely directed they balance one another, or produce *equilibrium*.

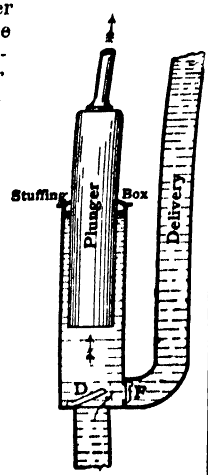
Weight, pull, and also push are, therefore, correctly called forces. At the point of contact of the weight and spring we have two equal and opposite forces acting—the downward pull of the weight and the upward pull of the spring—and these, when considered together, constitute what is called a *stress*. Stress, therefore, is of a dual character, and force may be regarded as one aspect of a stress. This is in exact accordance with Newton's third law of motion, which states that: 'To every action there is always an equal and contrary reaction, or the mutual actions between two bodies are always equal and oppositely directed'. The existence of forces can be inferred only from their effects, which are: (1) balancing other forces, when they produce equilibrium; (2) setting bodies in motion; and (3) their action upon the voluntary muscles when they can be felt. The unit of force commonly employed is the pound weight avoirdupois, but other gravitational units are also used, such as a ton, an ounce, a hundredweight, &c.

In pure science, absolute units of force are

usually employed, an absolute unit of force being that force which, acting upon unit mass for unit time, will produce unit velocity. [H. B.]

Force Feed Drill. See DRILL.

Force Pump.—Force pumps differ from the ordinary suction pumps in that they are required to raise the water *beyond the height of the bucket, and the top is enclosed so that as the water is raised from the well it may be forced to the required height.* They may be single action or double action; in the latter case provision is made for suction and delivery on both the up and down stroke. Force pumps may be of the bucket or plunger type, or of a combination of them. The force required to work a pump is equal to the weight of a column of water whose base has an area equal to that of the bucket or plunger, and whose height is equal to the height to which the water is being raised. As an example, where in a plunger pump the diameter of the plunger is 7 in., let the distance from the plunger to the water in the well be 13 ft., and the height to which the water is to be raised 30 ft. above the plunger; then the force required to work the pump during the outstroke and also during the instroke will be as follows:—



Force Pump

$$\text{Area of plunger} = \frac{7^2 \times \cdot 7854}{144} \text{ sq. ft.}$$

Volume of water whose weight is equal to pull on

$$\text{plunger} = \frac{7^2 \times \cdot 7854 \times 13}{144} \text{ cu. ft.}$$

$$\text{Weight of do.} = \frac{7^2 \times \cdot 7854 \times 13 \times 62 \cdot 5}{144} = 217 \cdot 14 \text{ lb.}$$

Which is the force required to perform the outstroke.

Volume of water whose weight is equal to push on

$$\text{plunger} = \frac{7^2 \times \cdot 7854 \times 30}{144} \text{ cu. ft.}$$

$$\text{Weight of do.} = \frac{7^2 \times \cdot 7854 \times 30 \times 62 \cdot 5}{144} = 501 \cdot 1 \text{ lb.}$$

Which is the force required to perform the instroke.

There are many devices for securing the passage of water up the outlet pipe. In practice the height of the suction valve above the well is not more than 26 ft., although the height of the water barometer is about 34 ft. The pump has therefore to be limited to this height above the water, and staging is necessary in deep wells. By the hydrolifter, however, where the pump is attached to the lower end of the pipe, the pipe can be practically any length, and be worked from the surface. This is effected because the whole pipe is raised and lowered. There is no piston or piston rod, but the base of the pump is made bell-shaped, and as the pump is lowered water is forced up it into a chamber between two valves, each charge advancing the water up the outlet pipe, a vacuum being formed on the upstroke which ensures the inrush, the continuity being maintained as in an ordinary force pump. See also PUMPS. [W. J. M.]

Forcing.—This term is applied in horticulture to the treating of plants, &c., to a higher temperature than they are usually grown in. It *enables the gardener to produce flowers, fruits, and vegetables out of season, generally in advance of the normal season. He forces grapes so as to have them in June, strawberries to ripen in midwinter, potatoes and other vegetables in early spring, while such flowers as* roses, lilies, lilac, hyacinths, daffodils, rhododendrons, and violets he can, by the application of forcing methods, obtain in perfection at almost any time of year. Plants, however, vary considerably in adaptability to this treatment. Some will not bear forcing, and others can be forced only in spring. Others, again, require to be put through a preparatory process before the extra heat is applied. Generally a temperature varying from 10 to 20 degrees above what is usual for the plant is sufficient to force it into active growth. A forced plant is always tender, and easily falls a prey to disease. It is therefore necessary to take precautions against fungoid and insect diseases. Judgment must also be exercised in the matters of moisture and shade. [W. W.]

Foreign Agriculture. See EUROPE, UNITED STATES, ARGENTINE, &c., AGRICULTURE OF.

Fore Milk. See MILK.

Forester.—DUTIES OF.—Foresters' duties are usually in Britain of a very miscellaneous description, and include far more than the ordinary work in the nursery and the woodlands. Where there is an estate sawmill it is generally in the forester's charge, as is usually also the entire supervision and maintenance of the roads, hedges, and fences throughout the estate. And very often, too, he has to act as a steward and farm bailiff. Hence, as in other walks of life, regular method and management are desirable so that all the various operations may be duly performed at their proper time—although regularity and fixed hours as to daily supervision and personal movements throughout different woods, plantations, or parts of the estate where labourers are at work are neither desirable nor advantageous. As all economic methods are based on proper consideration of probable income and expenditure, the first duty of a prudent forester is to draw up a brief financial statement for the coming year, showing where the falls of hedgerow, field and woodland timber, coppice, &c., are proposed to be made, and the yield and income, or estimated value, expected from its sale or other method of disposal; and detailing the location, extent, and cost of the various operations of enclosure, drainage, and soil-preparation of land to be planted or of woodlands to be renewed, of maintaining the nursery and beating up, weeding, and cleaning young plantations, of pruning, thinning, underplanting, and other operations of tending the woods, of making and maintaining roads, fences,

ditches, &c., of sawmill work, of woodmen and other establishment, and of whatever other special duties are entrusted to his charge. Countersigned by the agent or landowner, such a document should be the authority for the forester's work during the coming year, an approved scheme which he is expected to work up to. When such an arrangement has been in force for a year or two, the annual statement submitted can then be made to show for easy and useful comparison—(1) the actuals for the past year, (2) the revised estimate for the present year, and (3) the forecast for the coming year. The full extent of the year's work and the available funds being thus fixed, and the necessary books having been opened for Cash Account, Daily Labour and Piecework, Sales Book of Timber, &c., Ledger, Stock Book of Timber, &c., Nursery Stock Book, and Sawmill work, the forester can proceed to forecast his work month by month throughout the coming year. Say it is already the month of June before he can thus map out his work, he can then roughly note operations in something like the following manner (but detailing the locality and extent of the operations for guidance at the time):—

July.—Examine land that may need draining; weeding, cleaning, and pruning in nursery; examine fences and clipping of ornamental evergreen hedges; collect material for road repairs; weeding young plantations.

August.—Prepare ground for autumn planting; weeding and clearing in nursery; collect ash, hornbeam, yew, and thorn seeds and mix them with sand, but sow birch at once; prepare big ornamental trees and shrubs for planting, and begin transplanting them about end of month; begin marking timber for winter felling.

September. — Complete soil - preparation for autumn planting; carry out enclosure, drainage, and burning of heather and rough scrub; inspect fences and roads, repair fences damaged during harvest operations, trim the thorn hedges, and prune broken branches of park and hedgerow trees; examine and clear drains; continue marking timber for winter felling; begin carting fuel and making charcoal required; hoe and clean nursery beds, and set layers and cuttings; collect ripening tree-seeds.

October.—Begin lifting and despatching from nursery, and planting on the light soils and with the broad-leaved trees; collect oak, beech, and other seeds as they ripen; arrange for sale of timber for winter felling; mark off and sell coppice-hags.

November.—Continue planting, and push it on to the utmost possible extent; begin winter fellings by carrying out thinning operations and felling timber required for estate work or sawmill; continue collection of tree seeds for storage; inspect and clean drains and ditches.

December.—Continue timber-felling and extraction, and begin roadmaking and repairs; open drains on marshy land from which mature timber is removed.

January. — Continue timber-felling and extraction, roadmaking, and opening new ditches or cleaning old ones; begin trenching and manuring in nursery.

February.—Complete felling and extracting timber, and commence planting on the heavy soil and with the coniferous trees; push on nursery work, and collect larch and pine cones.

March and April.—Complete spring planting, and beat up the blanks in young plantations; push on nursery work, transplanting seedlings into the lines and preparing and sowing the seedbeds, so as to complete such nursery work by end of April.

May, June, and July.—Weeding and cleaning in nursery; continuous inspection of young plantations especially, and of the woodlands generally, to note any signs of insect attack, fungous diseases, damage by game, vermin, &c.

The above are only rough suggestions, which can easily be very greatly improved on by any forester desirous of systematizing the work entrusted to him.

Education.—It is practically only since 1885 that anything has been done in the way of teaching modern forestry in Britain; and it is only since 1903 that effective recognition has been given to the fact that before much can possibly be done in the way of national afforestation, or even the improvement of our existing three million acres of woodland, it is necessary to provide good instruction in forestry both for our future landowners, land agents, and forest officials, and for practical foresters and wood bailiffs. Formerly there was no proper forestry teaching whatever for the land-agent class, while practical foresters only got an altogether unorganized and very rough rule-of-thumb training as apprentices at woodland centres like Scone, Dunkeld, or Strathspey, or else in the large nurseries near Edinburgh and elsewhere. Thus, when young forest officers were needed for the Indian Forest Department from the year 1866 onwards, they had to be sent to France and Germany for technical instruction in forestry; and when their training was transferred to Cooper's Hill in Surrey in 1885, this formed the first organized forestry teaching given in Britain. For many years previous to this, however, the necessity for proper instruction had been kept in view by the Highland and Agricultural Society (which held examinations) and by the Scottish Arboricultural Society, and a forestry exhibition was held at Edinburgh in 1884 to try and raise funds for establishing a forestry professorship. This object was not achieved, but sufficient attention was drawn to the subject to obtain the appointment of a Select Committee in 1885 to consider the question of forestry education and the improvement of our woodlands. Its report, issued in August, 1887, merely suggested schools in England, Scotland, and Ireland, and recommended the creation of a Forestry Board to establish forest schools and conduct examinations. The first step in such a direction was the establishment of a lectureship in forestry at Edinburgh University in 1889, during the same year as the Board of Agriculture Act was passed in which provision was made for collecting forestry statistics and inspecting forest schools, aiding forestry instruction, &c. This Act gave no power for directly carrying out the recommendations of the Committee, but it enabled annual grants in

aid to be made from 1891 onwards of £100 to the Edinburgh lectureship, of £250 toward the professorship of agriculture and forestry at Newcastle, and from 1892 of £150 each to the free instruction of foresters and gardeners at the Royal Botanic Garden, Edinburgh, and to the Glasgow Technical Institute. As these measures were merely partial and inadequate, the Board of Agriculture in 1902 appointed a Departmental Committee to enquire into forestry and technical education, and its report recommended lectureships in forestry being established at Oxford and Cambridge, and a good grounding in forestry being given at all agricultural colleges, as well as provision being made for a two years' course of systematic and practical instruction for young foresters and woodmen in the Crown forests or in State woodlands to be specially acquired as demonstration forests. So far as State action was concerned, as the result of this report the Commissioners of Woods and Forests in 1904 organized a small school for the instruction of practical foresters at Coleford, in the Forest of Dean (for the regular management of which a working plan had been drawn up in 1897 and adopted), the apprentices each week working four days in the woods and receiving instruction on the other two, and a grant of £250 a year was given for lectureships in forestry at the Armstrong College (Newcastle) and Bangor College (North Wales); and since then State-aided forestry instruction has also been provided, since 1904, at the agricultural colleges of Wye (Kent), East of Scotland (Edinburgh), West of Scotland (Glasgow), and North of Scotland (Aberdeen). For several years prior to 1902, lectures on forestry had formed part of the estate management curriculum at the agricultural colleges of Downton (Salisbury) and Aspatria (Carlisle), and nominally also at Cirencester; but the first step taken by private enterprise was the establishment of a chair of forestry and estate management at Cirencester. For the special requirements of Ireland, the Avondale estate (Rathdrum, Co. Wicklow) was bought in 1904, to be a school for the training of apprentices as working foresters and woodmen, six being admitted each year and the course extending over three years (see also below); while arrangements are now under consideration for instituting a course of instruction for land agents, &c., at the Royal School of Science, Dublin. In 1905 the Indian forest students were, owing to the impending closure of Cooper's Hill College in 1906, transferred to Oxford, and in October, 1907, a readership in forestry was established at Cambridge, so that the amount of forestry instruction given throughout the United Kingdom at present may thus be summarized: (*a*) For landowners, land agents, and officials: (1) *Universities*—Edinburgh, Newcastle, and Bangor (B.Sc. degree); Oxford and Cambridge (Diploma): (2) *Agricultural Colleges*—Cirencester, Aspatria, Wye (Diploma); East, West, and North of Scotland (Highland and Agricultural Society's Certificate). (*b*) For working foresters and woodmen: (1) in England, Coleford (Forest of Dean); (2) in Ireland, Avondale (Rathdrum). Scotland has as yet no recognized place of instruction for practical foresters and woodmen, although Scone or Murthly might form a good centre (or Inverliever, the new State forest, in course of time). The forestry instruction required to qualify young men of good education for performing properly the administrative and executive functions of forest officers, land agents, and landowners managing extensive woodlands ought either to include, or else to be preceded by, a fair grounding in the elements of the cognate sciences—geology, botany, zoology, chemistry, and physics. No deep study of any one or other of these is necessary, but it should be something beyond a mere smattering; and it should at any rate include the elements of forest botany, a sound knowledge of the principles of each science, and be so co-ordinated as to enable the student to understand the known facts and the present theories connected with soil science and plant physiology, the two great foundations of modern scientific forestry, and to learn all that is necessary about fungous diseases and the life-history and habits of woodland animals, and especially of injurious insects. And, of course, he must have a sufficient knowledge of elementary mathematics to enable him to acquire a fair practical acquaintance with surveying, levelling, roadmaking, and elementary engineering. With such a scientific foundation to work upon, it is easy to impart technical instruction on the theory and practice of forestry; but it is most desirable that classroom lectures should be combined with outdoor demonstrations in woodlands, and that (if possible) the indoor teaching should have been preceded by some sort of practical training in woodland work.

The various subjects which a complete course of lectures should include have already been given (see art. FORESTS AND FORESTRY); but unless combined with practical work in the woodlands themselves, academic instruction alone will not qualify any student for managing woodlands. For the technical education of the working forester or wood bailiff a good ordinary board-school education of the higher standard in rural districts is needed, in order to graft thereon a fair knowledge of elementary science, and a good training in practical work, such as is given at the Avondale Forestry School in Ireland with a view to so combining theory and practice that the young men trained there should be able to adapt themselves to the various conditions under which they may have to work in the future. Apprentices who have already done manual work are there received in autumn, after written and oral examination, and the training extends over three years. During the first two years the apprentices are engaged in manual work during the day, and receive class-work instruction from 6 to 8 in the evening, the first year's apprentices being taught elementary science (physics, chemistry, and botany), and those of the second year forestry, forest biology (botany and zoology), surveying, and estate management. This special forestry course (part of which is given out-of-doors) includes lectures on (1) general character and distribution of forests, (2) fundamental principles of economic forestry,

(3) biology of timber trees, (4) sylviculture, (5) management of woods, (6) protection of woodlands, and (7) utilization of woodland products. During their third year the apprentices (who are paid a good wage) are available for work in any part of Ireland where their services may be required, and arrangements have been made by which landowners intending to plant can obtain their services to supervise or to carry out practical forestry work for which the ordinary local labour is not sufficiently skilled. This not only assists planters, but also gives the young men experience in different parts of the country and in the management of work and of men. [J. N.]

Forest Fly. See HIPPOBOSCA.

Forest Laws. See arts. on ARBORICULTURE; ARBORICULTURE, STATUTES RELATING TO; *and the following article.*

Forests and Forestry.—*Forestry is the* art of managing forests and woodlands. But these two terms are by no means synonymous. Under ancient English and Scottish statutes there were separate forest laws which only applied to all such tracts (and these not necessarily wooded tracts) as were set apart as royal hunting grounds, and which then became exempt from the operation of the ordinary common law applicable to all other areas, including woodlands. Thus almost treeless wastes, such as the Scottish deer forests and the Dartmoor forest in Devon, are examples of the originally legal or technical meaning of the word 'forest', while none of the great blocks of plantations formed within any part of the United Kingdom during the last 250 years are necessarily 'forests' (unless situated within the limits of the ancient Crown forests), but are simply 'woods and plantations'. Thus the Department which deals with the remnants of the ancient forests and other woodland properties of the Crown is styled the 'Office of Woods and Forests and Land Revenues of the Crown'. In its latest application, however, the term 'forestry' means the management of woodlands upon business principles for the production of timber; and in this more limited signification it is synonymous with sylviculture, in contradistinction to arboriculture or the cultivation of trees (see art. ARBORICULTURE). Arboriculture was the principal feature of the national British system of woodland management which developed during the 15th and 16th centuries with the special object of encouraging the growth of oak timber for the navy, and which only became practically a lost art in the course of the last century, when wooden sailing vessels were replaced by iron steamships and the old methods of locomotion became completely revolutionized. Even in Anglo-Saxon times very numerous royal hunting grounds and game preserves or parks had been reserved for the king's pleasure in most parts of the English kingdom, and at the Norman Conquest these passed into William I's possession. But the mild and simple rules then applied to the 'upper chase' after deer and the 'lower chase' after minor game were then made very stringent and savage, while the existing boundaries of such preserves (not necessarily woodlands, though usually including some woods for the deer browsing) were in many cases extended, and each was formed into a *foresta* or forest, a Norman-latinized form of the Old German *Forst* in use since the 9th century under the German emperors. This new term was introduced into the Domesday Survey of England made in William the Conqueror's reign, and thenceforth became incorporated into the English language. The New Forest in Hants (new in the sense of its more formal *afforestation* and of its enlargement by the extension of its boundaries) and the Forest of Dean in Gloucestershire are by far the largest and the most celebrated of the areas then afforested which still exist as extensive Crown properties containing a large proportion of woodlands. During the time of William II to Henry II the kings encroached greatly on the private rights of their subjects, and some of the new afforestations had to be disafforested (each such tract then becoming a *purlieu* of the forest). The first genuine code relating to the forests was the Assize of Woodstock, 1184, which, although harsh and arbitrary, placed the forest law upon a distinct footing apart from the common law, and established special 'Justices in Eyre' for trying forest cases. But matters again became critical, and special provisions about mitigating the oppressiveness of the forest laws had to be embodied in Magna Charta (1215), five of the sections of which relate specially to forests; while in 1217 a special Forest Charter abolished some of the worst abuses and ordered a perambulation and revision of all forest boundaries in 1218. But still the conflict went on through successive reigns, the king always trying to encroach until the barons almost rose in revolt, when concessions were reluctantly made, only to be repudiated whenever this seemed possible. Thus fresh Forest Charters and Ordinances were made in 1299, 1305, 1306, and new perambulations were ordered in 1299 and 1327, while each sovereign was on his accession forced to confirm the forest clauses of Magna Charta and the great Forest Charter.

By this time the forest laws had become crystallized. There were three Courts of the Forest: (1) the Woodmote or Court of Attachment, ordered by the Forest Charter of 1225 to be held every forty days (but often held irregularly to the great general inconvenience), for preliminary enquiries and attachment or presentation to the next higher Court; (2) the Swainmote or Court of Freeholders, ordered to be held thrice a year, in which 'verderers' appointed from among the neighbouring gentry were the judges and twelve 'swains' or freeholders formed a jury (corresponding to the twelve jurymen in trials under the common law), which could convict and fine in all petty cases, but could only commit serious offences to the next Justice Seat; and (3) the Justice Seat or Eyre of the Forest, ordered to make an *Iter* or circuit once every three years to try as a High Court, with the assistance of a jury of 18, 20, or 24 freeholders, all offences presented to it from the Swainmote. The forests were held to consist of 'vert' and 'venison', respectively meaning forest produce of any sort (trees, bushes, grass,

turf, &c.) and game. The three greatest offences against vert were 'purpresture' or trespass and enclosure, 'waste' or clearance of cover, and 'assart' or rooting up woodlands for conversion into arable or pasture land, which was only permitted by special royal licence. Till 1540 the high noblemen necessarily filling the office of Justices in Eyre had to perform their duties in person, but after that deputies were allowed by statute. During Charles I's reign, royal encroachments were again made, but the Commons disallowed them, and in 1640 passed an Act of Limitation which virtually abolished the office. Charles II tried to revive this high court, and circuits were held by Vere, Earl of Oxford, at Lyndhurst in the New Forest, in 1669 and 1670; but so great and general was the dissatisfaction that the Justice Seat then fell into abeyance, though the nominal office was not abolished till 1817, when the duties were by statute vested in the First Commissioner of Woods and Forests.

The forestal conditions in the United Kingdom are now as follows (in acres):—

Country.	Land Area.	Woods and Plantations	Waste Lands	Percentage of Woodland.	Percentage of Waste.
England	32,382,550	1,715,473	2,305,823	5·3	7·1
Scotland	19,070,244	868,409	9,374,512	4·6	48·1
Wales	4,748,624	184,361	1,250,813	3·9	26·2
Ireland	20,350,725	306,661	3,779,640	1·5	18·5
Total for Great Britain	56,201,418	2,768,243	12,931,148	4·8	22·7
Total for the United Kingdom ...	76,552,143	3,074,904	16,710,788	3·9	21·6

The comparatively poorly wooded condition of the United Kingdom generally, and of each of the four countries separately, may be seen from the following statistical table concerning the other chief commercial countries in Europe (acres in round numbers):—

Country.	Land Area.	Woodland Area.	Percentage of Woodlands.
Germany ...	133,585,000	34,570,000	26·9
France ...	130,374,000	22,224,000	17·0
Austria-Hungary	155,000,000	46,452,000	30·0
Belgium ...	7,277,000	1,260,000	17·3
Denmark ...	9,500,000	683,000	7·2
Holland ...	8,038,000	634,000	8·0

The British Isles were no doubt in primeval times quite as densely wooded as any part of continental Europe. But our comparatively early and very intense industrial development soon led to such extensive clearance of the original woodlands that but few large and compact remnants of these now remain, such as, for example, the Forest of Dean and the beech woods on the Cotswold and Chiltern hills in England, and some of the Scots pine woods in Strathspey. Thus the necessity for restrictive measures with regard to timber felling, and particularly as regards oak for shipbuilding and the navy, was early felt in England. Although an Act of Enclosure (1482) had been passed for all woods in forests, chases, and purlieus, permitting landowners to fence their copses for seven years against deer and cattle, yet so great was the dearth of shipbuilding and other timber fifty years later that an Act for the Preservation of Woods (1543), generally known as 'the Statute of Woods', was passed to prevent the owners of woodlands from felling the standard timber trees in their copses except under observance of certain fixed rules, and to compel them to 'store' young standards of oak, or failing that of 'elm, ash, asp, or beech', which were then the most valuable kinds of timber (oak for shipbuilding, ash for agricultural implements and bows, aspen for arrows, and beech for furniture). Thus the previously existing copsewood method of storing standard timber trees above an underwood of hazel, oak, ash, &c., cut at regular intervals of from about 8 or 10 to 20 or 25 years, according to local circumstances, became by statute the typical national form of British forestry. And as the want of navy timber became greater later on, this statute was amended from time to time and its observance enforced. And this continued down till the early part of last century, when the present era of improved transport and facilitated communications began to dawn. The characteristic feature of this national system of forestry was that the individual trees were treated arboriculturally and given a free individual growing-space, so as to provide strong knees and crooks for ships' timber; whereas now the sylvicultural methods of modern forestry aim at growing long straight stems close together, so as to get the largest and most valuable crop of timber per acre from the ground, and at the smallest cost of production.

The woodland and other areas under the management of the Commissioners of Woods, Forests, and Land Revenues of the Crown consist (apart from 15,175 ac. at Windsor, Ascot, Bagshot, and Virginia Water, maintained as royal domain around Windsor Castle) of about 98,000 ac. The largest is the New Forest in Hants, aggregating 64,834 ac., but only 24,356 ac. actually belong to the Crown, while 40,478 are open heath and pasture, the enclosure and planting of which is prohibited by an Act of 1877. The most important as to woodlands is the Forest of Dean in Gloucestershire (18,710 ac.). The other and smaller woods and forests aggregate 16,574 ac., situated in Cheshire, Gloucestershire, Hants, Isle of Wight, Northants,

Surrey, and other counties. But in addition to these remnants of the ancient English royal forests, other 10,348 ac. have been appropriated for plantations, and purchases of woodlands and plantable lands have during the last hundred years been made in Great Britain (though not yet in Ireland) of 20,258 ac. at a cost of £234,863 for forestry purposes, the chief being Highmeadows and Tintern, adjoining Forest of Dean (7039 ac., £204,863), and, quite recently, farms in Wales (655 ac., £5000), and Inverliever, in Argyllshire (12,500 ac., £25,000). Since 1897, when a regular working plan was formed and applied to the Forest of Dean and the Highmeadow woods, similar schemes of management have been drawn up for the Alice Holt, Esher, and Tintern woods, and planting is being done in Wales and at Inverliever under a scheme drawn up by the Forestry Adviser to the Office of Woods, specially nominated in 1907 to this new and useful appointment.

The private woodlands throughout the United Kingdom aggregate about 2,950,000 ac., but the vast majority of them have been formed and are maintained chiefly for ornament, shelter, and game preservation. Most of them are therefore *not intended to be managed on business principles; and even where any sort of endeavour is made to combine profit and enjoyment, strict economical principles are seldom applied. It is* therefore impossible to subdivide this woodland area so as to show the respective total acreage of ornamental woods, shelter-belts, and woods worked solely or mainly for profit. But some landowners have adopted definite working plans for their woodlands (*e.g.* Duke of Bedford, Woburn; Earl of Selborne, Blackmoor; R. Munro Ferguson, M.P., Raith and Novar; and others), and it is only when some sort of regular system of management is thus followed that there can be a proper adjustment of capital and returns in timber, and that an economical method can become assured.

Owing to the absence of large woodlands and to its vast industrial development Britain has been long almost entirely dependent on imported timber for the supply of its large and ever-growing requirements. Its annual bill for timber therefore far exceeds that of any other country, as the following statistics relating to timber and wooden goods alone will show (in round numbers):—

Country.	Imports.		Exports	
	1895	1905.	1895.	1906
	£	£	£	£
United Kingdom ...	23,274,000	25,242,000	765,000	2,160,000
Germany	7,333,000	13,176,000	2,628,000	2,930,000
France . ..	5,204,000	6,680,000	1,778,000	2,120,000
Austria-Hungary ..	412,000	565,000	7,000,000	12,510,000
Sweden	246,000	332,000	6,357,000	7,749,000
Belgium	2,656,000	5,040,000	—	
Denmark	1,049,000	1,475,000	69,000	23,000
Holland	2,822,000	5,200,000	—	—
Switzerland	484,000	856,000	128,000	200,000
Russia	—	—	4,019,000	7,687,000
Norway	—	—	1,535,000	1,939,000

In 1906 our imports of wood and timber alone (including furniture woods and manufactured wood) amounted to £29,500,000. Of this £6,400,000 was for hewn wood, chiefly pitwood for our coal mines, which are absolutely dependent on foreign imports, and £18,500,000 for sawn wood, mostly spruce and silver fir, while the amount increased by about £5,000,000 during the years 1902 to 1906. And besides that, woodpulp amounted to £2,900,000, while millboards and paper mostly made from wood amounted to £5,100,000, so that our whole imports of all these classes amounted altogether to £37,500,000. This annual bill for wood is rising rapidly, and is certain to increase very greatly in future, although a very considerable proportion of what we need for pitwood and pulp for paper might quite well be grown on our waste lands and low-grade pastures, while at the same time such woodlands would provide other special advantages in affording increased employment, shelter to crops and live stock, and in tending to prevent floods and soil erosion, and to regulate and purify the water supply throughout all well-wooded catchment areas.

As to the general utility of forests in well-wooded countries, these are partly climatic and physical, and partly economic. The former may be briefly summarized as follows: (1) Woodlands tend to equalize the atmospheric temperature in their vicinity, and to modify its extremes both from day to day and throughout the year. (2) They also tend to reduce and to equalize the soil temperature throughout the woodlands. (3) By cooling the atmosphere, they tend to reduce its power of containing aqueous vapour, and therefore increase its relative humidity and bring it nearer to the point of saturation, below which any further decrease in temperature must occasion aqueous precipitations. (4) By their overshadowing they prevent rapid evaporation of soil moisture, and therefore tend towards increasing and maintaining the water supply, and regulating the flow of moisture within the soil; (5) and this, together with their mechanical protection in hindering soil erosion and in acting as safeguards against the rapid off-flow of rainfall and the inundation of low-lying tracts, assists in feeding and in maintaining regularity in the flow of springs, and in equalizing the

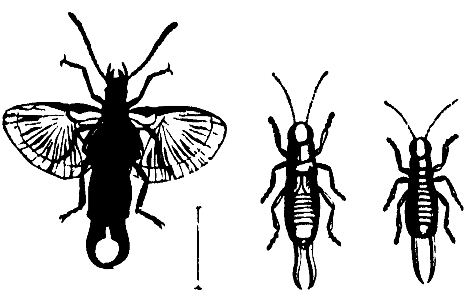
volume of water in brooks, streams, and rivers. (6) They also at the same time act as great natural filters for the purification of the water supplies drawn from their catchment areas. (7) They tend to exert a hygienic effect on the atmosphere through the oxygen given off in assimilating carbon from the carbon dioxide in the air; and (8) they provide beneficial shelter to agricultural crops and pasture lands. And all of these climatic and physical influences are, of course, during the winter time exerted much more effectually by evergreen (coniferous) crops of trees than by deciduous (broad-leaved) woods. And, of course, these climatic and physical influences are of all the more importance, the hotter the climate is and the drier the air. In countries like India and Australia, wherever they still exist the woodlands exercise a most beneficial effect, and wherever they have been too extensively cleared their want is now being greatly felt. Their economic effects are self-evident as regards the raw material they supply to a nation's industries, and the employment they give both in the woodlands themselves and in the transport, fashioning and conversion, and distribution of the wood and of its products in all stages of manufacture. Thus it has been calculated that the forests in Germany provide employment for about one-tenth of all the industrial classes, and the means of livelihood for over one-sixteenth of the total population.

During a great part of last century the Royal Society of Arts, and the Highland and Agricultural Society of Scotland did much to promote timber planting in Britain, but now the chief agents in focusing public attention on forestry are the Royal Scottish Arboricultural Society (founded in 1854), the Royal English Arboricultural Society (1881), and the Irish Forestry Society (1901). Partly through the parliamentary and other influence thereby exerted, various Commissions have during the last twenty-five years been appointed to enquire into and report upon forestry in Britain. These include two Select Committees of the House of Commons on Forestry (1885 7), and on the Management of the Crown Woods and Forests, &c. (1889), two Departmental Committees on British Forestry (1902-3) and on Irish Forestry (1907-8), and a Royal Commission on Coast Erosion and Afforestation (1908), to the recommendations made by which partial effect is being gradually given.

Technical instruction in modern forestry at any British college dates from 1885, when the training of probationers for the Indian Forest Service (hitherto obtained in Germany, 1867-75, or in France, 1867-86) was begun at Cooper's Hill in Surrey, at the cost of the Government of India, which was transferred to Oxford in 1905. In most cases, partly aided by grants from the Board of Agriculture, courses of instruction for landowners, land agents, and wood managers have since then been established at the Universities of Edinburgh (1889), Durham (Newcastle) and North Wales (Bangor) in 1903, Oxford (1905), and Cambridge (1907), and also at the agricultural colleges at Cirencester, Aspatria, Wye, Edinburgh, Glasgow, and Aberdeen (all since 1903-4). And for providing practical and theoretical instruction for working foresters, forest schools have been established by Government at Coleford, Forest of Dean (1903); Rathdrum, Co. Wicklow (1904), and Penicuik, Midlothian (1908).

Like agriculture, the modern art of forestry is based chiefly upon the cognate sciences of geology, chemistry, botany and zoology, and physics; and the principles upon which it rests are those specially concerned with the physics and chemistry of atmosphere, soil, and plant, the essential facts relating to vegetable physiology and to the biology of fungous diseases and noxious insects, and the application of precise methods to all calculations regarding woodland crops and their rate of growth. A complete course of theoretical instruction in forestry usually is divided into four main branches: (1) sylviculture, or the formation, tending, and renewal of woodland crops; (2) management of woodlands, and measurement and valuation of timber; (3) protection of woodlands, and (4) utilization of woodland produce (for detailed information concerning which, see arts. on SYLVICULTURE, WOODLANDS, MANAGEMENT, PROTECTION, AND UTILIZATION OF). But such theoretical instruction alone can be of little use without ample opportunities for practical work in the woods, for neither the farmer nor the forester can be educated merely in the lecture room or the laboratory. [J. N.]

Forficula auricularia (the Common Earwig) infests almost every crop, and probably



Earwig—Adult, Pupa, and Larva

injures the fructification of the flowers, although it has been said to feed also upon thrips and aphides. Earwigs have a most delicate pair of ample wings, very curiously folded up under the little square scales which cover the back; and they have been taken on the wing in the sunshine, and also in moonlight nights. They seldom fly, however, and many species do not use their wings at all. The female is distinguished by shorter and straighter forceps than the male, and she lays a number of eggs, over which she broods. Earwigs avoid the light, and are especially fond of hiding places where there is only a small crevice for entry. This characteristic renders them easy to trap. A favourite but unsightly plan is to place inverted flower-pots filled with hay on the tops of sticks near infested plants, and shake them out in the daytime. Less objectionable, because less conspicuous, are poi-

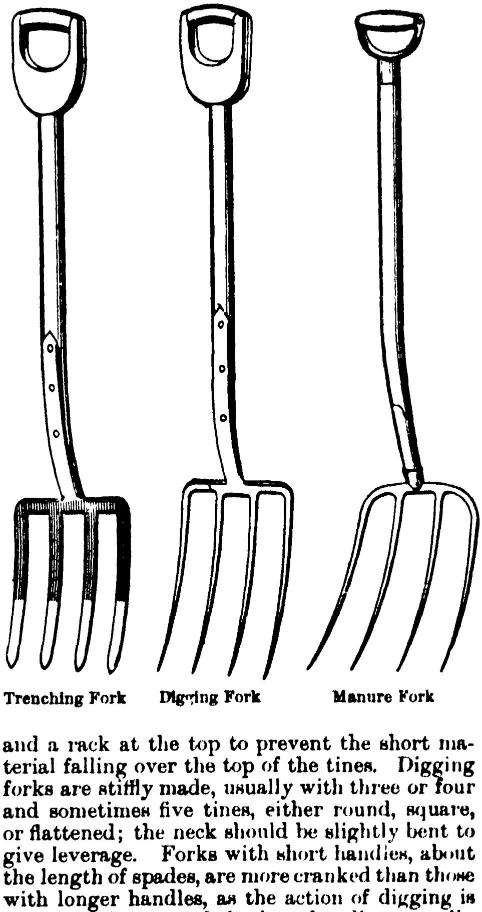
tions of elder sticks with the pith pushed out and the upper end corked up. Some writers maintain that the Earwig is much less injurious than is generally supposed, but it is undoubtedly a troublesome pest to the horticulturist, often retarding the growth of ornamental plants in their early stages, and spoiling the flowers at a later period by nibbling the petals. Dahlias especially suffer, and the hollow stalks left over from the previous year often harbour large numbers of the insect. Such stalks should be scrupulously removed. [J. C.] [C. W.]

Forget-me-not. See Myosotis.

Forging, a word which is synonymous with 'speedy cutting', 'buffing', or 'brushing'. See Brushing.

Forking.—Forking land to dig out pieces of Couch or other weeds is not nearly so commonly practised as it was thirty years ago, the higher price of labour and the lower price of farm produce tending to make many farmers keep down their labour bill. Where economy is practised in matters which only go to produce a neatness without any substantial benefit, there is reasonableness in so doing; but the forking out of small patches of Couch from leys, or a root crop just previously to sheep being placed on it, and on other occasions when by a small expenditure a field can be made perfectly clean, is sound farming. Small patches of Couch soon become large ones, and much of the value of fallowing may be lost by not carrying through the cleaning to this stage; and at any rate the next fallowing will be a much more expensive one if it is not done. Forking should be done thoroughly or it may almost as well not be done at all; each root or stolon should be followed to its end and be picked up and carried off the field. The four-tine fork or graip is the best tool for this purpose. Sometimes on heavy land it is impracticable to shake the Couch free from the sticky earth at the time of digging, and in such a case the patch should be dug out and thrown on the surface to mellow under the influence of weather, and be gathered up subsequently. Forking, or the use of the fork, should be performed more easily than many do it. In digging, the strain of lifting should be taken by the body, bent for the purpose; the arms being regarded as connecting rods, and the wrists as universal joints to give the necessary turns and jerks to effect the work. Whenever collecting light material is done, or when heavier material is thrown to one side, the forker should swing towards the natural direction of the lower hand; he then gets the assistance of a long body swing, which he does not do when he throws in the other direction, nor can he work so quickly. [W. J. M.]

Forks.—Forks are known by several names according to district; in some they are pikes, pooks, prongs, &c., all denoting the same tool. Forks take several shapes according to the nature of the work to be done. The use of steel has done much to lighten forks, which were very heavy as made by the village blacksmith, and it is now rare to see these tools in most districts. The two-tine fork is used for moving light material, and is very commonly spoken of as a pitchfork, but the pitchfork is a specially large fork used to pitch hay or corn on to wagons; the next size is the emptying fork, made stout and strong to empty loads (in piecework districts) where there is sometimes considerable resistance in getting up a good forkful. The smaller forks are known as turning and collecting forks, and are made light because they have little load to carry, and should be worked quickly. Caving or pooking or cocking forks are made to collect short materials, such as cavings and clover haulm, to pitch them on to carts or to carry them, or to gather short-strawed barley or other crops to form cocks. They are provided with long tines,



Trenching Fork   Digging Fork   Manure Fork

and a rack at the top to prevent the short material falling over the top of the tines. Digging forks are stiffly made, usually with three or four and sometimes five tines, either round, square, or flattened; the neck should be slightly bent to give leverage. Forks with short handles, about the length of spades, are more cranked than those with longer handles, as the action of digging is different, the user of the long handle generally getting some leverage from his leg above the knee. In the piecework districts (and in these the most convenient tools and the best methods of using them are adopted) the short-handled fork, requiring the user 'to put his back into it', is almost always used; the longer handles being commonly spoken of as 'lazy men's forks'. The short-handled fork or graip is equally well suited to load manure, spread it, or to dig. Lighter graips or forks with more than two tines are used for moving light farmyard manure, for cleaning out byres, and similar work. Potatoes are dug by the ordinary four-tine fork, though

some prefer those with flat tines; the flat tines, however, are more liable to cut the tubers, as they cover more ground. Specially stout forks are used for carrot and parsnip digging. [W. J. M.]

Formaldehyde and Formalin.—The substance which is known as formalin is a solution of formaldehyde, H·CHO, the aldehyde of formic acid. Formaldehyde itself is a very volatile liquid, which, as it readily undergoes polymerization to the solid paraformaldehyde, is ordinarily used as the strong solution known as formalin, since it is comparatively stable in this form. Formalin contains about 40 per cent of formaldehyde. The bottles containing it should be kept closed, as it rapidly loses strength by formaldehyde vapour escaping into the atmosphere. The vapour has a peculiar odour, and a powerful irritating action on the nose and eyes. Until recently formaldehyde was a mere chemical curiosity, but about 1886 its powerful antiseptic properties were noticed. Since then it has come into extensive use for a great variety of purposes.

Formaldehyde is one of the most powerful antiseptic, disinfectant, and preservative substances known. In this respect it is far more powerful than carbolic acid, and is comparable with the strongest antiseptics known, such as corrosive sublimate. It can be used either in the form of solution or of vapour, and as its value as a disinfectant has become known its use in both these forms has extended very rapidly. Many forms of lamp have been devised for generating it as vapour, and as it is a far more powerful disinfectant than sulphur dioxide it has largely replaced that gas for disinfecting rooms. It can also be used in dilute solution for washing walls, floors, ceilings, clothes, &c., in order to disinfect them. A 1-per-cent solution of formaldehyde, that is, 1 part of ordinary formalin diluted to 40 with water, is effective as a disinfectant against nearly all organisms. A solution of formalin is useful for such purposes as washing and disinfecting the hands or instruments which have been contaminated with septic matter, for disinfecting the teats or udders of cows, or any other part of the surface of the animal body which may require disinfection. It is very convenient for use in disinfecting byres, stables, and outhouses, as the solution can be sprayed over walls and partitions and into all chinks and crevices. For such purposes it has the great advantage over mercuric chloride (corrosive sublimate) that it is not strongly poisonous to human beings and higher animals.

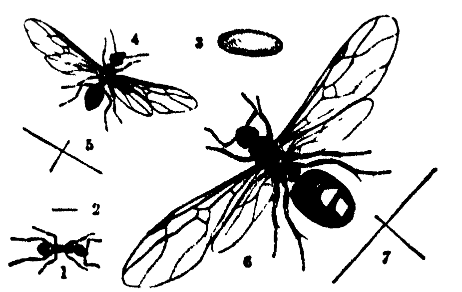
Attempts have been made to use it as a preservative for foods. At one time it was extensively used as a preservative for milk. Very minute quantities are sufficient to preserve milk from decay for two or three days. Although in these small quantities it is not actively poisonous, it has an injurious action upon digestion. Its use as a preservative for foods has therefore been forbidden in nearly all countries. Formaldehyde has also been introduced as a preservative for meat, fish, game, butter, eggs, and such substances in the form of vapour. The articles to be preserved are placed in a special chamber and exposed for a time to the fumes of formaldehyde, produced by heating tabloids of paraformaldehyde, known as 'paraform', in a special lamp.

Solutions of formaldehyde have also been used as fungicides. Certain fungoid diseases of plants are combated by spraying with a dilute solution of formalin. Attempts have also been made to destroy the spores of fungoid diseases in seed of different kinds and in bulbs by washing with a solution of formalin, or by exposing to an atmosphere containing formalin vapour.

A quite different use to which formalin is put is the hardening of protein substances, such as casein. Casein hardened by means of formaldehyde is now used for making imitation ivory, horn, and tortoise shell. These preparations have the very important advantage over the much better known and cheaper xylonite or celluloid that they are not readily inflammable. Nitrocellulose preparations, such as xylonite, are very easily set fire to and burn fiercely; on the other hand, casein-formalin preparations are not easily set fire to, and when they catch fire are easily extinguished. In this they resemble genuine ivory and horn. Formaldehyde is also used for hardening and rendering insoluble varnishes prepared from casein. Its use for these purposes has created a new market for the casein, which is obtained as a by-product from the excess of separated milk produced by creameries.

Dilute solutions of formalin have largely replaced spirit as a preservative for specimens both vegetable and animal. If placed in a 1-per-cent solution of formaldehyde, vegetable and animal substances of any kind can be preserved indefinitely from decay. A solution of formalin has the advantage over spirit that it is incomparably cheaper. It is also non-inflammable, and a better preservative. [J. H.]

Formicidæ, the scientific name of the ant family of insects. These familiar insects, though



An Ant of the Genus Lasius

1, Worker, enlarged; 2, Its natural size; 3, Pupa, commonly called the egg; 4, Male, enlarged; 6, Female, enlarged: 5 and 7, Their natural sizes.

more or less of a nuisance in the garden, and sometimes accused of stealing the farmer's seed, do no serious harm, their presence on plants being generally due to their fondness for the 'honey-dew' deposited thereon by aphidæ. A very minute species of ant, *Monomorium pharaonis*, has rather recently been introduced into

England, and infests houses in some towns, and rather serious expense is sometimes incurred in the attempt to exterminate it on account of the inaccessible position of its nest, which is generally near the kitchen fireplace. [C. W.]

Forpit, a dry measure whose capacity was one quarter of a peck, formerly used in Scotland but now obsolete.

Forsythia, a genus of shrubs (nat. ord. Oleaceæ) with yellow flowers, which being abundantly produced on the naked branches in March and April, make these plants of great value for garden decoration. *F. suspensa*, from China, which will attain to 12 ft. in height, is the most valuable species. It can be grown in masses in beds, the shoots being annually cut back, and it is also an effective pillar or wall plant. *F. viridissima*, also from China, is of stiffer habit and does not grow so tall. It owes its names to the green colour of the wood. *F. intermedia* is a hybrid between the two; while *F. europæa*, a recently introduced kind, is not equally meritorious. These plants are also valuable in giving a bright display early in the year if brought into the greenhouse. They prefer a rich soil, and are readily propagated from soft cuttings. [W. W.]

Foul in the Foot, Loo, Low.—A painful foot lameness, more frequently occurring in a hind foot, and due to a variety of causes, is known by the above names in different localities. Overgrown or ingrown digits, injuries in rough pastures and upon stubs in hedgerows, and constant friction between the claws in dry weather and on stubbles, account for most of these injuries to the more sensitive structures between the digits and those composing the coronets. Lameness, with heat and swelling, mark its invasion, and the process of suppuration or abscess formation (see Abscess) is protracted. Loss of condition, falling off in milk, and inability to get about in the field attract attention, and treatment should be at once adopted. Cows accustomed to handling may be poulticed continuously, but they are bad subjects as a rule, and kick until they are rid of appliances of a loose kind. Failing to retain these, a thick smear of yellow basilicon ointment on old calico should be retained in place by a long narrow bandage or tarred cord passed between the digits and around the pastern. With the natural rupture or judicious lancing of the abscess there is great relief, but a 'core' often remains to be got rid of by further similar treatment, and final healing is promoted by the application of friar's balsam, or a weak solution of zinc chloride if fungoid granulations are disposed to show above the level. [H. L.]

Foulness in Land.—Foulness in land is due to the profuse growth of weeds, and though certain soils and districts favour the development and the spreading of some very troublesome weeds (*e.g.* Couch and Pearl Grass), yet foul land is too often the evidence of careless farming. The sowing of impure seed, imperfect and shallow cultivation, and the inefficient cleaning of land when under green crop are the commonest causes of foulness, and the remedy lies in the avoidance of these errors. Weeds in pastures, such as docks and thistles, should be cut early to prevent seeding; repeated cutting ultimately kills them off. In some parts of England the practice of paring and burning is adopted in the cleaning of old sainfoin pastures, which are apt to become very weedy. Liberal manuring forms an efficient aid in keeping land clean. A rapid growth of the crops is thus secured, which chokes off any weeds that may spring up. Cultivated crops have their own special weeds. Charlock in cereal crops can be killed off by spraying with a 4-per-cent solution of copper sulphate. Corn spurrey is kept in check by giving a late harrowing after brairding. Knot Grass can only be removed by chain-harrowing the ploughed land previous to green cropping, and gathering and burning the weed. Deep ploughing in most cases is efficacious in burying weed seeds and preventing their aftergrowth. The method commonly adopted to check foulness is to give the land a thorough cleaning when under green crop, and in special cases the growth of two green crops in succession affords a good opportunity for the thorough extermination of all weeds. See also Cleaning and Weeds, Eradication of. [R. H. L.]

Foumart (= foul martin), a name given to the polecat on account of its offensive smell. See Polecat.

Foundations. See Buildings.

Founder. See Laminitis.

Four-horned Sheep.—Although sometimes considered to constitute a distinct breed,

Four horned Sheep

four-horned sheep appear beyond doubt to be descended from casual sports that have arisen from time to time in diverse breeds, and have been preserved either by the inherent dominance of the character in inheritance, or by intentional selection for breeding purposes by fanciers. They occur in such widely separated countries as Iceland, India, South Africa, Chile, and elsewhere. In Chile, according to Darwin, the Spanish sheep, which are descended from the Merino breed, generally have four horns. In the South African piebald or 'Zulu' sheep, which were supposed by Col. Farrer to have been introduced into that country by Portuguese or Spanish settlers, the rams also are commonly four-horned, whereas the ewes are hornless or have but a single small pair. In these sheep

the tail is long. But in the four-horned sheep from Nepal, four well-developed horns are usually present in the ewes, and the distinctness of this breed from the South African breed is attested by the shortness of the tail, which is flat and pointed, and only about 4 in. long. Both in the Indian and South African types the *horns are black, in correspondence with the large amount of black distributed in patches over the body and legs, and especially prevalent on the head; but in the small St. Kilda four-horned breed the horns are brown like the fleece. Four horns sometimes occur in the Blackfaced Scotch mountain sheep.*

When four horns are developed those of the inferior pair almost invariably curve downwards and outwards. The direction of those of the upper pair, which arise above the bases of the lower, is more variable. Sometimes they rise upwards and backwards like the horns of a goat, sometimes upwards and outwards, and sometimes they curl strongly forwards over the face and have to be cut short. That the additional horns have originated by division of the horny substance of the two normal horns is probable. Occasionally two horns are present upon one side of the head and one upon the other, while in rare cases each of the four horns is itself subdivided, so that eight separate horns are present. In the island of St. Kilda and in some of the isles in the Outer Hebrides there still exists a breed of four-horned sheep. These represent merely the remnants of a very ancient type, of which a few flocks are still kept on some estates in England and Scotland. They are small, hardy, and active, with a fleece of fine wool. The colour may be white, black, or brown, or a mixture of these, the St. Kilda sheep generally being of a light-brown colour. The mutton is very sweet, and the sheep yield about 8 lb. per quarter. Some of the Shetland sheep have also four horns. [R. I. P.]

Fowl Louse. See MENOPA.

Fowl Pest. See POULTRY, DISEASES OF.

Fowls, Breeding of.—In the breeding of fowls the chief point to be considered is the purpose for which they are intended. To the breeder of fancy poultry, who seeks perfection of external characters only, such as comb, plumage, &c., and who cares little or nothing for economic properties, no real difficulty presents itself. He simply eliminates, as far as possible, all that does not conform to his ideals. But the breeder who seeks for the best results in producing those fowls which will excel in laying powers or in meat qualities only, has a more difficult task before him. The ultimate gain is by no means certain, as fowls of this type rapidly deteriorate, reverting to ancestral forms. And when we try to improve both external characters and economic properties, unexpected complications arise, and the work is slow. Something must be sacrificed. Heavy egg-laying or fine and abundant flesh are seldom accompanied by a high-conditioned plumage, great development of comb, or size of body.

Breeding is, and must ever be, largely a matter of selection, in that we have to be constantly striving to maintain improvements already secured, and to increase and develop them. The tendency to reversion, or atavism as it is termed, has always to be contended with, as poultry breeders of every grade know. The producer of exhibition stock finds this in various ways. Loss of size, mismarked feathers, failure of artificial characters, are constant *sources of difficulty. The tendency to variation leads to changes which he does not desire, and in his seeking for fixity of type he has a constant battle to fight against the 'throwing back' to the original form.* In the older breeds this is less seen than in the newer, but it is more or less present in all. The utility poultry breeder has the same struggle. By selection he has developed egg production or the flesh qualities until they are altogether abnormal. Only by constant selection can they be maintained and increased. It is unnatural for a hen to lay 150 eggs per annum, or to weigh 8 or 9 lb., and any neglect on the part of the selector for a season or two will assuredly have the effect of destroying what it has taken years of patient effort to build up. It is for this reason that farmers can do comparatively little to advance either the egg-producing or the meat qualities of domestic poultry, as they have not time for such a task, which must be left to specialists, who, by the larger returns in the shape of sale of eggs for hatching or of stock birds, obtain a reward for their labour and skill.

It is desirable to consider the question whether for practical purposes the use of pure- or cross-bred fowls is preferable. There is much to be said in favour of each. Mongrelism, by which is meant an indiscriminate mixture of breeds, lacking in any measure of uniformity, is practically unknown in nature, where the tendency is always towards a given type, provided that the conditions are equal. The barn-door fowl (see BARN-DOOR FOWL), as we have already seen, was distinctive, and in many cases might have been regarded as a definite breed. It was not a mongrel. The system, which yet prevails on many farms, of introducing into the general stock every year a number of male birds, in many cases totally different from any employed previously, and often following fashion, could not make for success. It would not be employed with any other class of stock, which is sufficient to totally condemn it. Crossbreeding is the mating of two distinctive breeds with a clear object in view, whether egg production or meat properties. The reason adduced in favour is that the progeny are usually much more vigorous than either of the parents, which is, as a rule, quite correct, though the effect in that direction is limited to one or two generations. Upon this question, observations with respect to Mendel's law of breeding may have much to teach, but cross-bred birds are not usually preserved, and hence in poultry we have not experienced great benefits therefrom. The vigour referred to is undoubtedly beneficial and profitable. Fowls need strength of body to stand the strain of prolonged laying, or to bear forcing for early maturity—so desirable in table birds, and to that extent the use of cross-bred birds is advisable. On the other hand, they are not

of the same value as breeding stock, and the loss of those special characters which go to the making of a distinctive type detracts from the appearance of the birds, in which there is considerable value. In the production of pure-bred races, especially under artificial conditions and where refinement is carried to an excess, there *is always a tendency to lessened virility*, and *it is for this reason that objections have been raised against pure or standard breeds.* But *loss of virility is due far more to false systems* of breeding and bad management, to excessive development of minor characters, or to inbreeding, and though the latter is a rapid method of attaining certain results, it nearly always results in debility of constitution. It is not necessary, and can be avoided by the adoption of commonsense methods. The fact is, that all the best-laying strains of fowls are pure breeds, and the majority of the best table fowls produced in this and other countries are pure-bred. On the whole, we recommend pure breeds to farmers rather than crosses, though the latter have an acknowledged value for special purposes.

The question is complicated, however, by the methods adopted in the drafting of standards of excellence, which have been left entirely in the hands of fanciers, who, caring little or nothing for egg or meat properties, have devoted their attention entirely to external characters, such as colour of plumage, markings, ear lobes, points on the comb, &c., and in other cases have aimed at size of body only. That all these characters have some reason and possibly some value is undoubted, although we have not as yet fully realized what it is; but when the more important qualities are sacrificed in order to secure greater perfection of those which are useless or may be injurious, but yet encouraged by the false standards laid down, then the result is serious indeed. For instance, the crest in the Houdan, which was originally small, has been increased by selection to such an extent that it becomes a nuisance to the bird, and an injury to its economic properties. In some of the breed standards, nearly fifty points out of a hundred are given to colour of plumage or markings, the result being that nearly everything is sacrificed for colour. Standards we must have, but those of to-day are often harmful in the extreme, and the practical poultry keeper is well advised not to be bound by their fantasies. He should take the general type as of chief importance, in respect to which the shape, guided by the work the breed is destined to perform, is of greatest value.

This brings us to consider the question of size of body. For flesh-producing races we must have a large frame, capable of carrying meat in abundance, yet not excessively large, otherwise increase of bone will mean slower growth and greater cost of production. As a rule, birds of the best races for table purposes weigh from 7 to 10 lb. when fully grown, that is 4 to 6 lb. during the chicken stage. Hens which are usually the best layers are small in size of body, and it is an interesting fact that size of eggs has no relation whatever to the weight of body. Many of the largest breeds produce small eggs, the best results being obtained from those races in which the birds weigh from 3½ to 6 lb. The Spanish breeds produce large-sized eggs in considerable numbers, but they naturally do not exceed 5 to 6 lb. Other Mediterranean breeds, such as the Leghorns, not so big as the Spanish, are very prolific, *but the eggs are not so large in size as those from the Spanish.* The same is true *of Belgian breeds such as the Campine and the Braekel, which are even lighter in weight.* Hence we must look to those races which have not large bodies for the best results in egg production, and even within a breed it will generally be found that the finest layers are on the small size.

A final point is that careful selection should be made of the entire stock of birds for breeding purposes, and eggs from these alone be used for hatching. That selection should be in accordance with the object in view, whatever that may be. The plan, which is still all too common, of running several male birds with the entire flock of hens, and taking eggs for hatching from them when they are wanted, is not calculated to secure that control which the poultry keeper must exercise if he is to maintain and improve the quality of his stock and obtain the best results. Frequently it means he is breeding from the worst instead of the best, under which conditions he cannot hope to make the enterprise successful. Accommodation can easily be provided for these separated birds in one or more portable houses, or even within an enclosed run. But the principle is one which should be rigidly adopted by every poultry keeper, no matter how large or small his operations. [E. B.]

Fowls, Breeds of.—The number of breeds of fowls is very large, and is increased by the fact that many breeds embrace two or more varieties. Moreover, the list is being constantly added to.

No good purpose would be served by giving a list of lesser-known breeds, as many of these have never been seen in this country. It will be enough if reference is made to the method adopted of dividing or classifying the various breeds. From the economic point of view it is not a question of country of origin, of size of body, or of colour of plumage, but of these qualities, namely, the production of eggs, the quality and quantity of flesh. Hence we divide the breeds as follows: (1) Laying or non-sitting breeds—breeds which excel in laying powers. These are usually small in size of body. (2) Table breeds, those specially characterized for their meat properties. (3) General-purpose breeds, having a combination of Nos. 1 and 2. These have obtained much of their popularity because of their size, and of the fact that they are good winter layers. (4) Ornamental breeds. Below we give the division of the various races:—

1. *Laying or Non-sitting Breeds.* — Ancona, Andalusian, Braekel, Campine, Hamburg, Houdan, Lakenfelder, Leghorn, Minorca, Redcap, Scotch Grey.

2. *Table Breeds.*—Bresse, Crevecœur, Dorking, Du Mans, Game, Indian Game, La Flèche, Sussex.

3. *General Purpose Breeds.*—Faverolles, Langshan, Malines, Orpington, Plymouth Rock, Rhode Island Red, Wyandotte.

4. *Ornamental Breeds.*—Bantams, Brahma, Cochin, Game Bantams, Malay, Polish, Spanish.

A description of each of these breeds is given in the articles under their various names.

[E. B.]

Fowls' Dung consists of the excreta of fowls. It possesses high manurial value. The manure from the poultry yard is often mixed with considerable quantities of ashes, and is variable in composition. Fowls' dung is not of the same importance as the dung of animals, because the total quantity produced is obviously very small. Though the weight produced is small compared with that of farm stock, its careful preservation should, however, not be neglected.

Hen dung has the following approximate percentage of composition:—

Water	60·0
Organic matter	19·2
Ammonia	1·75
Phosphates	4·3
Pot salts	1·10
Chalk	8·1

From the above analysis the fresh dung of poultry is rich in organic matter, and contains appreciable quantities of nitrogen, phosphates, potash, and some chalk. It is generally stored along with other refuse in the compost heap. In this way it makes a valuable manure for market-garden crops and for pot and garden culture. Pigeon dung has long been valued as a substance of high manurial value, and in the dried state it has been imported from Egypt and other parts for use as a manure in horticulture. Guano consists of the decomposed excreta and remains of sea-gulls and other marine birds. [R. A. B.]

Fowl Tick. See ARGUS.

Fox.—The name 'fox' is given to a group of species, widely distributed, especially over the Northern Hemisphere, belonging to the vulpine section of the Canidæ. Foxes differ from wolves in their more slender build, longer, more bushy tail, relatively shorter limbs, and larger ears. They do not hunt in packs as wolves do, nor are they known to interbreed with the dog. The Common British Fox (*Canis vulpes* or *Vulpes alopex*) stands about 14 in. high, and measures about 4 ft. in length, including the tail, which is more than half the length of the rest of the body. It has a broad head, pointed, tapering muzzle, and large ears, black outside and white on the inner aspect. The general colouring is reddish-brown on the upper parts, whitish-grey on the under parts, and the tip of the tail is usually white. Two races are distinguished—a mountain race, which is larger, with a relatively larger head and coarser hair of a greyer tint, and a smaller ruddier lowland race. They are usually known to gamekeepers as greyhound foxes and terrier foxes respectively. The frequent importation of individuals belonging to the larger Continental races is probably not without effect on our British foxes.

The fox is 'one of the oldest mammalian inhabitants of Britain', but even its undoubted cleverness and cunning would hardly have sufficed to save it from sharing the fate of its congener the wolf, if it had not been protected in many parts of the country for the sake of sport. It eats all sorts of animal food 'from a fawn to a beetle', and is often very destructive to game—partridges, grouse, leverets, and to rabbits. It also levies a heavy toll on hen-roosts, and has been known to carry off young lambs. Mice are eaten in great numbers, and dead fish from the seashore are not despised; but when the growing cubs have to be fed, an abundant supply of larger animals is required.

The fox spends the day in a burrow usually excavated on a slope under stones, or within the shelter of a thicket. The burrow of a badger is often appropriated, and the rightful owner sometimes continues to share it with the fox. Pairing takes place early in February, and the young (four to seven in number) are born usually before the middle of April. They are very helpless at birth, but are ready to hunt with their mother in three months. Cubhunting begins in September, foxhunting proper in November.

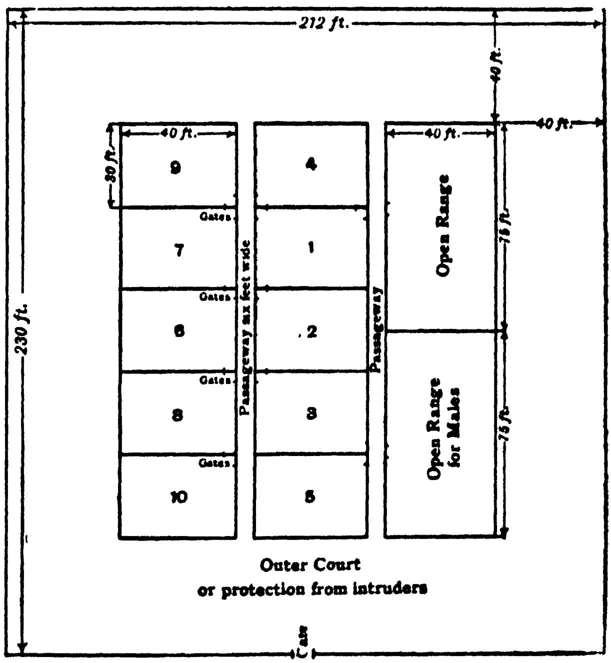
Fox

The skins of many of the allied North American and European species are brought to the London market in enormous quantities, that of the Silver Fox, which is black sprinkled with white, being the most valuable. [J. A. T.]

Fox Farming.—Fox farming is a new industry, and one which has still to be regarded as in its experimental stages. The Silver Black Fox is one of the highest-priced of our furbearers, and offers large returns for the application of skill and experience to its successful propagation in confinement. The following remarks are based on a report on the subject of Silver Fox Farming recently issued by the Biological Survey of the U.S.A. Department of Agriculture. From this report it appears that although many experiments in this line have failed, still a few have succeeded, and to such an extent that fox farming may soon become a well-established and profitable industry. The Silver Fox is closely allied to the Common Red Fox

(*Vulpes fulvus*) of Canada and North America, and varies in colour from grizzle to black.

In breeding foxes in confinement one would naturally expect that the closer the breeder approximates to the natural conditions under which wild foxes live, the more successful would his efforts be in securing the best returns and in producing skins of the finest quality. But this is by no means essential or even desirable, for if the enclosures be too large and afford too great a variety of conditions, the foxes will remain wild and unmanageable. If, however, the attempt be made to propagate foxes in too limited quarters or too near civilization, the animals will become restless or suspicious, and consequently will not breed well. The best conditions, therefore, are neither exactly artificial nor yet too natural. For their successful management, foxes require but little room, and thrive in enclosures not more than 40 ft. square. Half an acre will accommodate six pairs of foxes, a number which will be quite sufficient for any beginner to handle. In the selection of a site, much will depend on local circumstances, but efforts should be made where possible to include a few trees and small shrubs, and to choose a location where the soil is sandy in character. The general plan of a fox farm is indicated in the accompanying diagram. The fox-runs themselves, which are usually square in outline, are made of wire netting tightly stretched between upright wooden standards. The mesh of the netting should not be greater than about 2 in., and the fence should be about 10 ft. high and sunk into the ground 2 ft., while the top 2 ft. of the fence should be bent inwards at right angles and supported by crossbars from the upright standards. This is to prevent the animals from climbing out. The sunken part may be turned in about 1 ft., and flat stones should be laid along the inner edge of the enclosure to prevent the foxes' escape by digging. Inside this outer court are the inner enclosures, which are small, and only designed for single animals or pairs of animals. One or more of these enclosures, however, are larger, and serve to accommodate a number of animals at one time. Each compartment is provided with doors so that the animals may be readily transferred from the one to the other. The size of these compartments is at least 30 ft. square, but the larger runs usually measure 75 ft. by 40 ft. The smaller compartments should be arranged in two rows, with a passageway 6 ft. wide between. Each compartment should contain a small house or shelter box, much after the style of a dog kennel, and about the same size. No nesting materials need be provided in these boxes.



Plan for Arrangement of Fox Yards

FOOD.—Wild foxes live on a very varied diet, which includes mice, rabbits, birds, insects, and, in certain seasons, berries and fruits. Meat, therefore, should not form their sole diet if the best results are to be obtained. A mixed ration, which includes, besides meat, bread, milk, table scraps, and manufactured dog biscuits, is most suitable. The foxes should never be overfed, as when fat and sluggish they do not breed well. A healthy wild fox generally weighs from 6 to 8 lb., so that animals over 10 lb. are too fat. A regular daily ration is preferable to irregular feeding, not only because it produces a better animal and a better coat, but because it establishes a more intimate relation between keeper and fox. The best results have been obtained from a daily ration of ½ lb. of meat and a handful of table scraps. Occasionally a raw bone, or such titbits as wild mammals, rabbits, and mice, should be given in addition.

BREEDING.—Foxes breed only once in a year, the rutting season falling about the months of February and March. The period of gestation is fifty-one days, so that the young are born in April or May. The litter varies from two to eight, the average for adult animals being five. Male and female should be kept separate except during the mating season. They should be paired about December or January, and separated about March or April. The young foxes are small and weakly at first, but they grow rapidly, and when about six weeks they are able to come out and take a little milk or an occasional bit of solid food. The greatest care should be exercised during this season, and disturbance of all kind should be avoided. No

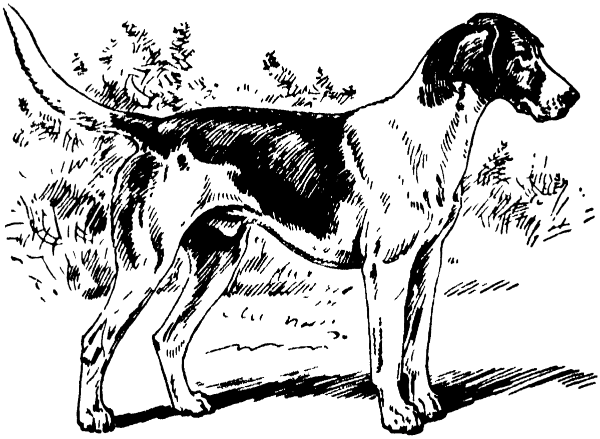
strangers should be permitted to approach the enclosures, as the foxes are naturally very suspicious, and betray the greatest anxiety for the safety of their young during this period. They have been known to search all round the enclosures for a suitable place in which to hide the offspring, with the result that in many cases the young have been so badly mauled and harried that they have died from the effects. They should be regularly visited by an attendant, who should do his utmost to gain their confidence.

CAUSES OF FAILURE.—The principal causes of failure in the past appear to have been due to the lack of close personal attention, to overfeeding, and to the want of seclusion and quiet.

The expense of fox raising is comparatively small, and after building the enclosures and securing the stock the running expenses are slight. The skin of every Silver Fox raised has a market value of over £25, while pure-black skins often fetch from £125 to £500 each. Live animals in good condition and suitable for breeding stock often bring twice the market value of their cured skins. Good live Silver Foxes can seldom be obtained for less than £125 per pair. Besides the Silver Fox the Blue Fox of Alaska has been experimented on by some fox farmers, but so far no results of any importance have been obtained. The common Red Fox of America has also been cultivated with much success, but the skins are of less value as they are comparatively common. [R. H. L.]

Foxglove, or **Purple Foxglove** (*Digitalis purpurea*), is a typical representative of the nat. ord. Scrophulariaceæ. The plant is a poisonous downy biennial herb, found wild on dry soils, by roadsides, and in open woods, but not in cultivated fields, and apparently never on limestones. In the first year of growth the plant is constructed of a taproot bearing a rosette of stalked ground leaves surrounding a central bud. Each leaf of the rosette is about 6 in. long, with a puckered surface and round marginal teeth. During the second year of growth the central bud expands and becomes a simple cylindrical stem about 4 ft. long, bearing leaves now only 3 or 4 in. long and without footstalks. Early in summer the terminal part of this stem bears the stalked flowers all hanging to one side, and now Foxglove is very conspicuous, since each flower has a purple bell-shaped corolla 1½ in. long and about ¾ in. broad. Ultimately fertilization occurs, the corolla falls off, and the fruit begins to form. When ripe, the fruit is composed of a two-chambered seedcase containing many minute seeds, which are shaken out when the seedcase opens for that purpose. A poisonous alkaloid called digitalin is diffused throughout the whole plant, but the leaves are alone used for making the medicinal tinctures and infusions, which possess very valuable properties. [A. N. M'A.]

Foxhound.—The existence of upwards of one hundred and seventy packs of foxhounds in England alone, which with those hunted in Scotland and Ireland brings the total up to over two hundred, affords a very practical illustration of the popularity of this canine family. From time almost immemorial the inhabitants of these islands have been devoted to the pleasures of the chase, which in the remoter periods of our history was a far more serious pursuit than it is at present, inasmuch as a successful hunting expedition resulted in the replenishing of an often very empty larder, whereas nowadays the main object in view is in the majority of instances the discomfiture of the fox. There can, however, be no sort of doubt that the modern Foxhound is a descendant of the trusted hounds which were associated with our ancestors in the chase, and



Foxhound

his descent from the old Southern Hound, a slow-hunting animal, but one possessed of marvellously acute scenting powers, admits of no denial. It is equally certain, however, that the modern Foxhound is a vast improvement upon the latter, so far, at all events, as the requirements of the age are considered; and probably there is no variety of the canine family in existence whose development has been a greater source of care and anxiety to its breeders, or upon which more money has been spent.

The result has been the appearance of a race of foxhounds the like of which has never been seen in any part of the world, and the existence of which supplies an eloquent tribute to the science and perseverance of those who have devoted years of anxious thought to its production. There, however, remains the indisputable fact that a stamp of hound which may be pre-eminently suited for one hunting country will be absolutely unadapted to another, and hence the difficulty that besets the writer whose object it is to describe the points of the breed. Fortunately, however, there are certain characteristics which are common to all hounds, and conspicuous amongst these is the marvellous faculty of scent which they all possess—of course, all breeds excepting the Greyhound display a 'nose' of

greater or less delicacy; but in spite of the high merits of the gun dogs, such as the Pointer or the Setter, it may be claimed for the Foxhound that in scenting powers he surpasses all.

Another trait of the hound family which all share in common is the straight fore leg and large round compact foot, as also the upward carriage of the stern and the graceful, sloping shoulders. These being not merely points which are characteristic of every breed of hound, but for the most part indispensable for their use for hunting purposes, it will be seen that such details of difference as exist between them are of minor importance after all, and therefore a general description of the Foxhound is not a matter of impossibility. It may therefore be left to the reader to modify the standard laid down so as to meet the requirements of different hunting districts, it being obvious to the practical man that a pack which has to hunt in a grass country should possess a greater amount of speed than one which does its work in a cramped country, where obstacles are many, and a long gallop over grass is practically unknown.

Taking the different points in order, it may be pointed out that the head of a Foxhound should be large and imposing-looking, but this does not by any means imply that it ought to be coarse. Quite the reverse, for massiveness is not to be confounded with coarseness, the Foxhound being a most aristocratic member of the canine race. The muzzle is both long and broad, the nose being large and the nostrils open and well defined, as in the case of all animals whose reputation depends upon their powers of scent. The eyes should not be light in colour, are remarkable for the keen, intelligent expression they display, the forehead above them being more developed than in the case of most breeds. The ears, which are set on low, should be carried close to the cheeks and are naturally rather long, but owing to the fact that it is the unvarying practice to reduce their dimensions by rounding off the tips they are, comparatively speaking, small. A long, graceful neck, absolutely free from any suggestion of dewlap or throatiness, is a great feature of the Foxhound, and this should be placed on long, sloping shoulders laid well back so as to ensure the possession of plenty of speed. The shoulders should be well clothed with muscle, but this ought not to be associated with coarseness, some foxhounds being inclined to this fault about the points of the shoulder, and if so they are not the thing at all.

The chest is of fair width, not too broad in the case of hounds which are required to travel fast, but it should be very deep, and the ribs must be well sprung, the body being very powerfully built, particularly about the loins, whilst the back is level and short. As observed above, the fore legs must be dead straight and very heavy in bone, whilst the feet should be round and compact, with thick soles and well-developed knuckles. The hind quarters are powerful, the stifles being well bent and the hocks near to the ground, whilst the stern, which is rather coarse, is carried gaily. The texture of the coat ought to be harsh, and it should also be dense and short, whilst the prevailing colours are black white and tan, black and white, and hare or badger pied. [v. s.]

Foxhunting.—Although foxhunting and the art of riding across a fenced country to hounds must be reckoned the most characteristically British of all field sports, it was not until far on in the 18th century that it attained esteem as 'the Noble Science' *par excellence*, nor was it brought to its present perfection, through careful breeding of hounds and better understanding of the condition of hunters, before the first quarter of the 19th century. Not until the nobler beasts of the chase—the red stag, the wolf, and the boar—had ceased to exist in the plains was the fox regarded as more than mischievous vermin, for the extermination whereof hill farmers used to keep a few couple of 'tender-nosed' hounds, which they brought together for a 'tod hunt' after the manner described in Scott's Guy Mannering, chap. xxv. It is believed that the first regular pack of foxhounds was formed by George Villiers, second Duke of Buckingham (died 1688), and kept by him at Helmsley in Yorkshire. The sport has continued to grow in favour ever since; and although its votaries have discerned successively in railways, wire fences, and agricultural depression the inevitable cause of its decline, it never was carried on with greater energy than at the present time. There are upwards of 200 regular packs of foxhounds in the United Kingdom, the maintenance of which cannot cost less than £600,000 a year, a trifling figure compared to the outlay incurred by the vast numbers of those who hunt with the different packs. These are more numerous than ever; for although landowners and farmers, formerly the chief supporters of provincial packs, have been too hardly hit by the fall in agricultural values to follow the chase so generally as of yore, their place in the field has been taken by men of means whom increased locomotive facilities enable to hunt from London and other great towns. Still, there is no kind of sport which depends so entirely as foxhunting upon the goodwill of owners and occupiers of land; for without the co-operation of owners, foxes could not be preserved, and farmers, were they ill disposed towards the sport, could take effective measures to prevent their fields being ridden over. It is only by mutual forbearance and consideration that this national pastime can be maintained —a point which should never be forgotten by townspeople who hunt and who perhaps have not been trained to distinguish the difference between seeds and stubble. The landowner who cannot afford to hunt will reflect on the pleasant social stir brought into any neighbourhood by a pack of hounds, and on the stimulus to local trade by the large expenditure involved. The farmer may find some indemnity for broken fences, trampled grass, and hustled stock in the readier sale on the spot of farm produce; and both squire and tenant, if they are versed in the history of their country, will remember that the greatest British general, the Duke of Wellington, attached so much value to the hunting field as a training ground for his officers that he maintained a pack of foxhounds in the Peninsula throughout his six years' cam-

paign against armies vastly superior in number to his own. It is true that the British cavalry in that war were admittedly inferior in quality to the French, but we have the testimony of the French General Marbot to the excellent scouting by British officers individually. 'In vain', says he, 'we sent our best-mounted horsemen after them. When a British officer saw them *approaching, he would set his excellent charger at a gallop, easily leaping banks, hedges, and even brooks, and making off so swiftly that our men, unable to follow him, lost sight of him, till presently he would reappear, a league further, on the top of some hillock, where, spyglass in hand, he resumed his observations.'* Training for such work as this could only be had in the hunting field, where alone proficiency in cross-country riding can be attained.

The regular season for foxhunting opens on 1st November, though cubhunting, at which young hounds are entered, is begun a couple of months earlier, or at the close of harvest. Of old it was the custom to prolong the season till a May fox had been killed, but modern conditions of agriculture, early lambing, &c., now make that impossible, except in places like the New Forest or on northern uplands.

Owing to their extensive pastures and the predominance of open country over woodland, the counties of Leicester, Northampton, and Rutland have long been esteemed above all others by foxhunters, and are distinguished as 'the Shires', other hunting countries being termed 'provincial'. But the counties of Warwick, Derby, Cambridge, and Oxford are little, if at all, inferior in the quality of 'going'; while those who have hunted in the Irish counties of Meath, Kildare, and Kilkenny generally give them the palm over all others in the United Kingdom. In Scotland most of the land suitable for the chase has been intersected with railroads and honeycombed with mines; but sport of high quality is still to be had in the counties of Ayr, Roxburgh, and Berwick.

The establishment of a pack depends for its scale, of course, on the number of hunting days in the week. To hunt four days a week will require not less than fifty couple of hounds in kennel. The master, if he carries the horn himself, must have at least ten horses in condition; if he has a huntsman, six or eight may serve himself, but the huntsman must have ten. The two whips require not less than a dozen horses between them, even in a light country; where fences are big and the work severe, the hunt servants cannot well do with less than thirty horses among them for four days a week.

When the master hunts the pack himself he deputes part of his duty to a field-master, whose part it is to keep those joining in the sport from marring it altogether, as they must inevitably do if left to their own devices. The first object to be attained is finding a fox; the second to force him into the open in order to give 'a run'. If the followers of the chase spread themselves at will round the cover which hounds are drawing, the fox, in attempting to break, is sure to be headed back at the risk of being ignobly killed in cover. The field-master, therefore, must be gifted with tact and persuasion, as well as authority, restraining eager and impetuous sportsmen and guiding ignorant ones.

Earthstopping is a humble but necessary function, which used to be discharged by a recognized official of the hunt, but is now usually undertaken by gamekeepers on their respective beats. The object of earthstopping is twofold: *first, to prevent the fox lying underground on the hunting day and so compel him to lodge above-ground, where he may be found and pursued; and second, to prevent him getting to* ground when found and pursued. As the fox is a nocturnal hunter, it follows that, if he is to be stopped out, the earth must be closed with a bundle of faggots before he returns to it. If this is delayed till dawn, it is very likely that the fox will be stopped *in* instead of *out*.

[H. M.]

Foxhunting (legal).—It was at one time considered that persons entering on the land of others for the purpose of following a fox with hounds could justify the trespass on the ground that the destruction of a noxious animal is for the good of the public, and this view was supported by the case of Gundry *v.* Feltham, 1786, 1 Term Rep. 334. The motive of the modern sport of foxhunting is certainly not the destruction and extermination of a noxious animal, and more modern cases have laid down that a person is not justified in entering the land of another against his will for the purpose of foxhunting. Thus in Paul *v.* Summerhayes, 1875, 4 Q. B. D. 9, 48 L. J. M. C. 33, the appellants were persons engaged in hunting with a pack of foxhounds, and sought to enter a field, part of a farm belonging to the respondent's father. The respondent warned them off, and endeavoured to resist their entry, and for the purpose of overcoming his resistance the appellants committed an assault, for which they were convicted. Upon appeal to the Court of Queen's Bench the conviction was affirmed, and Lord Coleridge, C.J., laid down that the sport of foxhunting must be carried on in subordination to the ordinary rights of property, and in the course of his judgment said: 'Questions such as the present fortunately do not often arise, because those who pursue the sport of foxhunting do so in a reasonable spirit, and only go upon the lands of those whose consent is expressly, or may be assumed to be tacitly, given. There is no principle of law that justifies trespassing over the lands of others for the purpose of foxhunting.' If a person who keeps hounds receive notice not to trespass on the lands of another, and after this his hounds go out and go upon those lands followed by a number of other persons, the owner of the hounds will be answerable for all the damage such persons do, even though he himself forbears to go on the lands in question, unless he has distinctly warned them not to go on those lands (Baker *v.* Berkeley, 1827, 3 Car. and P. 32). There is no law forbidding a person to kill foxes by traps or guns on his own land, though in hunting countries such a deed may be a social offence of the deepest dye.

[A. J. S.]

Foxtail Grass, the popular designation of

grasses belonging to the genus Alopecurus. See ALOPECURUS.

Fox Terrier.—The popularity of the Fox Terrier is astonishing, even to those who know the variety and appreciate his merits best, for no breed, however great its attractions, could be expected to maintain a position of pre-eminence in the canine world for over a generation, such as the Fox Terrier has succeeded in accomplishing. It must be remembered, too, that of late years this wonderful supremacy has been menaced by other varieties which have sprung, if not into existence at least into notoriety, long since the Fox Terrier first commenced to be a popular dog; but the advance of the newer varieties only seems to have added to the popularity of the older one.

The exact origin of the Fox Terrier is difficult to trace, for it must be admitted that our ancestors who kept dogs, good sportsmen though they undoubtedly may have been, were a little careless as regards the question of the breeding of their terriers, it being more a case with them of handsome is as handsome does than one of pedigree, so far as such varieties were concerned. It is perfectly reasonable to infer, however, as some writers and other authorities have done, that there was a demand a hundred years ago or thereabouts for a vermin dog that would not merely go to earth readily, but which could be depended upon to do his work well on land. The old English Terrier of the period was doubtless a nondescript sort of animal, which was descended from various miscellaneous sources, and as a consequence could not be relied upon to breed true, and therefore it is probable that the breeders of the day set themselves to work to produce a superior class of dog. The materials at hand were probably neither numerous nor particularly serviceable for the purpose, and possibly therefore the Terrier of the period was crossed with the Beagle or smallest breed of hound in order to combine a propensity for going to earth and destroying vermin, with the hunting spirit. This is at all events the theory which finds favour with many of those who have thought the matter out and searched the literature of the past; and it may be added that some of these gentlemen are under the impression that Bulldog blood was subsequently introduced with the object of infusing additional courage into the new production. This, however, would appear to be scarcely necessary, as it is morally certain that the terriers of those days partook largely of the Bulldog element, though in favour of the contention it can be laid down that Bulldog courage is the chief source of all canine pluck, and that very few if any breeds which do not inherit some of the blood of the national dog, no matter how late the cross may be, are conspicuous for pluck.

No doubt, too, the definition of Fox Terrier pluck is one which admits of two interpretations, as some people question whether a breed which is required to enter an earth and then to either bolt his fox or to direct the diggers-out to his whereabouts beneath ground by barking, should be so courageous as to attempt to kill his quarry in the earth. On the other hand, there are quite as many admirers of the Fox Terrier who contend that the courage of the breed is as high as that of any terrier in existence, which statement is open to doubt, especially when comparisons are drawn between the variety of their affections and the Bull Terrier. It is, moreover, the opinion of all the leading Fox Terrier authorities that brindled markings should be regarded as a most serious fault, the reason for their aversion to these being that brindle is not a Hound but a Bulldog colour, and although they claim the possession of Hound blood—presumably through the old Beagle—they desire to have no connection with the Bulldog. This involves no reflection upon the latter breed, in fact it supplies an indirect compliment to the immense courage it possesses; but a characteristic of the Bulldog attack is not merely that it is for the most part silent, but also that as a rule when a dog of this breed once gets a hold of his quarry he never lets go. Such a form of attack as has been pointed out above would not be suitable for a Fox Terrier to employ when engaged in bolting his fox or locating his whereabouts, and hence the prejudice that exists against the Bulldog cross amongst Fox Terrier breeders.

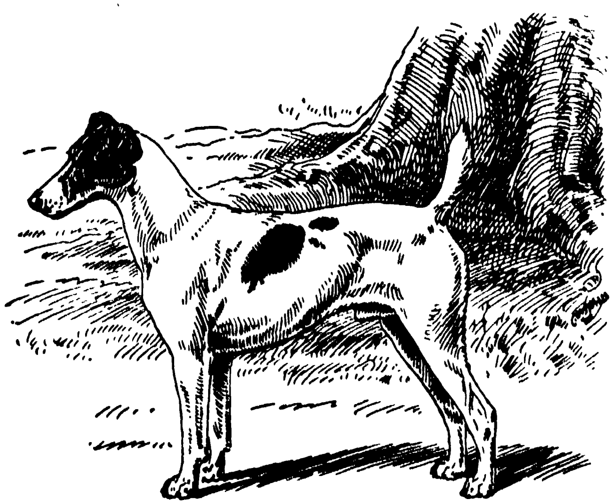
The fact, however, remains that there are now in existence many hundreds of fox terriers which never have been and never are likely to be brought face to face with a fox or badger, and hence the modern members of the family may be broadly divided into two distinct branches, namely those which are used for working purposes, and those which are kept merely as pets. Amongst the former are scores of undoubtedly very game terriers which are attached to the many packs of foxhounds which are spread over every district of the country. These terriers, or at all events the vast majority of them, possess no claims whatever to be regarded as show dogs, but they in most cases have been bred for generations with the greatest care from parents which have proved themselves valuable for the work they are kept to fulfil, and these may be regarded as the most eligible fox terriers of all. Many private owners also possess their own strains of fox terriers, whose working proclivities have been developed by long years of careful breeding, and which therefore abound in the possession of the vermin-destroying faculty. Such terriers on the face of it are likely to be far more congenial and useful companions to the country resident than the offspring of strains which have for years been bred solely for their show points, and which have never been used for vermin-destroying purposes. It is beyond all doubt the fact that the true working spirit in a dog is not merely hereditary, but that it is capable of being developed in the case of individual animals, and therefore if a Fox Terrier is required for work it is necessary that one of a right strain should be procured for the purpose.

This expression of opinion casts no reflection upon the modern show dog, some of which no doubt have been entered at vermin, though in the case of all of them appearance is the primary consideration. The exhibition Fox Terrier is merely what his breeders have made him, and although a leaven of the old pluck and working

spirit may lurk within him, it must be remembered that his value centres not in his ability as a working terrier, but rather upon his looks. Moreover, it is scarcely likely that the owner of a terrier which is handsome enough to win cups and prizes at a dog show would feel disposed to risk his animal being cut about by a badger or a fox, and thereby having its value depreciated, when he can find a more homely-looking terrier to do the work.

As regards the exhibition Fox Terrier, it may at once be stated that no variety of dog has undergone more changes in its appearance than he has during the last five-and-twenty or thirty years. Occasionally, moreover, these changes have been of the violent order, the result being that some breeders have scarcely been able to follow them up as effectually as others. The rage for harsh coats has resulted in a necessity for the wholesale trimming of coats, the art required for this being certainly beyond the capacity of most amateurs to deal with, the result being that professional assistance is often required to reduce the ultra-luxuriant jackets to reasonable dimensions. It has very often happened, therefore, that a dog purchased by some unsuspecting member of the public at a show has developed a totally different coat within a few weeks, and therefore Fox Terrier enthusiasts should be careful of whom they buy their dogs. Another great change that has taken place of comparatively recent years in connection with this breed is with reference to the height. The prevailing fashion is now all in favour of a very narrow-chested dog standing on legs of great length, but it is extremely doubtful whether the innovation is beneficial to the working powers of the breed, though his narrow chest enables the show Fox Terrier to enter drains which would be inaccessible to him because of his height if he were wider in the chest than he is.

The head of the Fox Terrier is rather narrow, flat on the top and tapering towards the nose. A dip appears between the eyes when the dog is viewed in profile, but if he is looked at from the front this does not show. The muzzle should be powerful, but there is a perceptible tendency towards weakness in the case of many show dogs, and the teeth should be strong and perfectly level, an overhung or underhung mouth being a very bad fault. The eyes are rather on the small side, just a trifle sunken and dark in colour, and the ears V-shaped, small, and carried close to the head with the tips rather forward; whilst the cheeks should be smooth, any protuberances at the base of the jaw being strongly suggestive of a Bulldog class. The neck ought to be clean-cut and of fair length, the shoulders sloping, the chest deep and narrow, and the back level and short, the body being compact and well ribbed up. The front legs must be perfectly straight, set on under the dog with no approach to be out at the elbow, and they should also be heavy in bone, the feet being round, with the toes close together and the knuckles well developed. The tail is usually docked, ought to be carried gaily, and the muscle on the thighs should be well defined. Colours vary considerably, black white and tan, black and white, and hound tan and white being the most common and the most appreciated, but all-white specimens of the breed, and also tan and white and black and white ones, often appear. The brindle colour, however little there may be of it, is regarded with very great disfavour, and a heavily-marked dog is not liked, as white shows up so much better underground. The weights of fox terriers are from about 16½ lb. to 18 lb. in dogs, and from 15 lb. to 17 lb. in bitches.



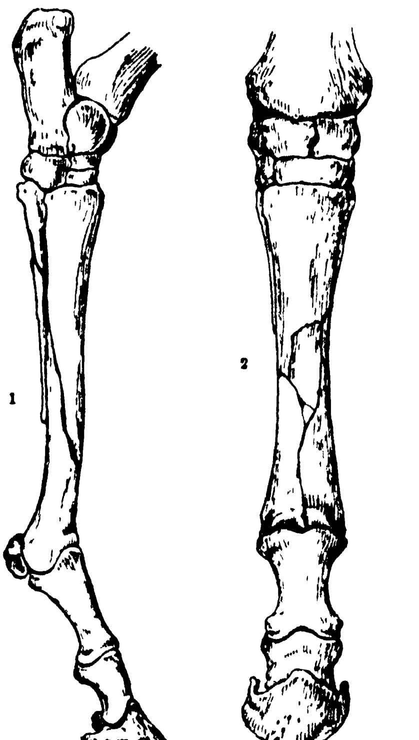
Fox Terrier

The question of coat is one that is accepted as being amongst the most important in connection with this breed—for there are two varieties of Fox Terrier, namely the smooth-coated and the wire-haired; of late years there has been a craze for producing a pin-wire texture of jacket amongst the smooths, and the results of the breeders in this direction have been undoubtedly successful. For all practical purposes, however, it will amply suffice if the coats of the smooth-coated are sufficiently harsh and close to resist the weather, as nothing can be worse than a soft, silky jacket, which not only fails to throw off the wet, but actually absorbs the moisture. These coats offer no protection to the dogs, who become perished by cold and wet, and therefore useless for working purposes on a bad day, and hence the importance of a sound, hard, weather-resisting jacket. The coat of the wire-haired variety should be as harsh and hard as it is possible to conceive it to be made; it should be profuse, and considerably longer than that of the smooth, whilst of course it is capable of keeping the dog warm and comfortable in every sort of weather. So far as their structural developments are concerned there is no difference between the smooth-

coated and the wire-haired breeds, in fact they are very frequently bred together with the object of improving the jackets of each. This is because the smooth coat is apt to become soft and silky unless there is an occasional infusion of the wire-hair blood, whilst the latter is disposed to grow too long and straggly if it receives no assistance from the smooths. As a consequence, many a good terrier exists which owns a smooth-coated parent on one side and a wire-haired on the other; but the two varieties being practically identical, the purity of their offspring's pedigree cannot be impugned.

[V. S.]

Fractures.—Broken bones do not necessitate the destruction of every animal, and it is important to contradict this popular belief, because many have been unnecessarily sacrificed to it. In the case of adult horses it is often

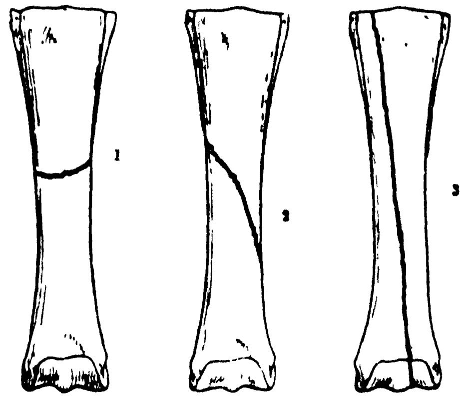


Fractures

1, Simple. 2, Comminuted.

necessary to slaughter on account of the expense attendant on treatment and maintenance, and the probability of some defect remaining after union of the fracture. It may be, too, that a fat beast will be more economically disposed of by the butcher than maintained during the long period necessary for repair, but in the case of young colts, calves, sheep, dogs, and in some instances pigs, treatment may be undertaken with fair prospects of success in certain kinds of fractures. These are generally divided into *partial or complete, simple or compound, comminuted or impacted.*

A simple fracture is one without any external wound or breach in the integument communicating with it. It may be transverse or longitudinal, involving a long or short bone, or only a portion or tuberosity. A fracture with wound is known as a compound one. If a bone is broken into more than two portions it is called comminuted. If the broken end of a bone is driven into the other, it is said to be impacted.



Fractures

1, Transverse 2, Oblique 3, Longitudinal.

Simple fractures, in the sense of being clean breaks across the shaft of a leg bone, will be converted into compound if one of the broken ends pierces through the skin, but may be worth treatment, where a crushed bone in innumerable pieces and having such a wound would be regarded as hopeless. Besides these, there is the green-stick fracture, which is best described by the name, and not infrequently occurs in the very young; rarely in the old, whose bones contain more mineral matter and less gelatinous than those of the immature.

Treatment.—Where there is no wound, the chief concern is to bring the broken ends of the bone into apposition and there retain them, preventing the patient from undoing the appliances by the various methods of restraint referred to under the heading METHODS OF CONTROL. Except in the case of so-called split pasterns there will generally be displacement, and in the larger animals it may be necessary to employ chloroform to relax the muscles before we can apply a splint. These are made of all sorts of materials, most of which are to hand in the farmhouse or homestead. The skin should be protected from galling by a bandage, upon which the chosen splint should be applied. Wood, leather, sheet tin, glue, starch bandages, tarred cord, brown paper—all of these have been applied successfully in such different animals as horses, cattle, sheep, pigs, dogs, and swine; shepherds particularly distinguishing themselves by setting broken legs with no more materials than rag and string, and a dressing of tar covered by wool while warm. Wounds com-

plicate the treatment, and must be first irrigated with disinfectants. If instead of removal of splints prematurely, a portion of the soft binding can be cut out, it becomes possible to treat the wound antiseptically without removing the support required by the bone. The clot formed by the blood soon undergoes changes, gradually hardening until enough and more than enough bony material is formed to firmly unite the broken ends. It is the superfluous material, or callus, which gives rise to trouble when interfering with the passage of tendons. [H. L.]

Frame.—A garden frame is a small portable greenhouse with a span or lean-to roof formed of sashes which are either fixed or removable. It is a most useful garden appliance, as it enables the cultivator to provide protection and trap sunheat for plants that require them; it also affords the most suitable conditions for plants that need nursing, and is useful for propagating purposes. The essentials in a good garden frame are lightness, good clear glass, and the right incline to prevent drip and to admit the direct rays of sunshine when required by the plants inside. The resourceful gardener can make his own frame by building a kind of shallow box without a bottom, and using a movable light for a lid. Frames are largely employed by market gardeners for the production of early crops of lettuce, radish, violets, &c. [W. W.]

France, Agriculture of. See European Agriculture.

Freehold. See Land Tenure.

Freemartin, the name given to a heifer born as a twin of a bull, and having the generative organs imperfectly formed, and often more or less hermaphrodite in character. The freemartin is essentially barren, and the external characteristics and fattening capabilities resemble those of the ox. Such female twins as have the female genital organs perfect, naturally result in productive cows (see Hermaphroditism in Animals). Freemartins are of rare occurrence among horses, but it has not been observed whether they are habitually barren. The female twin of a ram lamb is fertile. [J. B.]

Freestone, a common term for sandstones that are easily dressed for building purposes, or even for sandstone generally. Some limestones have similarly been called freestones. The Old Red Sandstone of Fifeshire yields good freestone. Another example is the fine-grained Carboniferous sandstone of Mount Charles in Co. Donegal. [G. A. J. C.]

Freezing. See Refrigeration.

French Bean, commonly called the Haricot or Kidney Bean. Its botanical designation is *Phaseolus vulgaris*. See Beans.

French Gardening.—An elaborate system of forcing plants and flowers under frames and on hotbeds composed mainly of horse manure. By this system, lettuces, radishes, strawberries are rapidly brought to maturity, while many vegetables and flowers in season and out of season can be produced fresh and sweet. See Intensive Gardening.

French Rye Grass. See Arrhenatherum.

Friction.—When one body is made to slide over the surface of another in contact with it, a certain resistance to the motion is experienced which is termed *friction*. This frictional resistance is due to the roughness of the surfaces of contact and is always opposed to the motion. Suppose a body of weight W resting upon a horizontal plane to be acted upon by a horizontal force F (fig. 1), which is gradually increased until it will just keep the body moving over the plane after it has once started; the frictional resistance will then be equal and opposite to F,

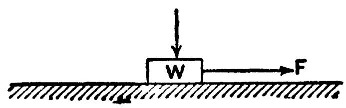


Fig 1

and the ratio of F to W is called the *coefficient of friction* between the body and the plane. Again, suppose the body placed upon an inclined plane, A B (fig. 2), and the plane gradually tilted until, after being started, the body will just continue to slide down the plane. If θ be then the inclination of the plane to the horizontal, θ or the angle B A C is called the *angle of friction*, and the tangent of this angle, or $BC \div AC = ad \div ac$ = friction (F) ÷ normal pressure (R) between the body and the plane, is the coefficient of friction.

Laws of Friction.—It has been found by experiment that the friction between two solid bodies when the surfaces of contact are dry, or

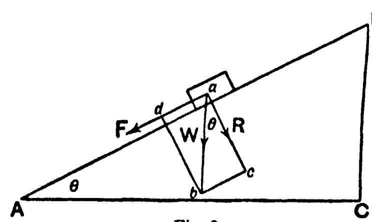


Fig 2

only very slightly lubricated, obey the following laws: (1) It is proportional to the normal pressure between the bodies; (2) it is independent of the area of the surfaces in contact, and (3) it is independent of the velocity of relative motion between the bodies. Rolling friction, or the resistance offered to the rolling of one body over another, practically obey the same laws, but is very much less than sliding friction. Consequently, advantage is frequently taken of this in practice by using ball or roller bearings instead of the ordinary journal bearing. Fluid friction, or the resistance offered to the flow of fluids over the surface of a solid, is due to the viscosity of the fluid and obeys the following laws: (1) It is proportional to the area of the wetted surface; (2) it is proportional, usually, to the square of the velocity with which the fluid moves over the surface of the solid; (3) it is independent of the pressure between the fluid and the solid, and (4) it is proportional to the density of the fluid.

Friction is of great utility in some cases, while

in others it is a source of waste and expense. Without friction, power could not be transmitted by means of belts and pulleys, winding engines and motor vehicles could not be controlled, and many useful articles, such as nails and screws, would be useless. In most cases, however, the friction between the moving parts of machines simply means a loss of energy accompanied by wear and tear, and it is in order to reduce these as much as possible that lubricants and other devices are used by the mechanic. [R. B.]

Friesian Cattle.—The Friesian, or Holstein-Friesian cattle as they are wrongly named in America, or Dutch as they are frequently designated in Britain, are a well-established breed, and according to Hengeveld have a history dating back well over 2000 years. They are descended directly from the cattle owned by the Friesians and Batavians, who occupied the regions north of the great rivers Vahal and Rhine, some 100 to 300 years B.C. The original Friesians occupied a far greater territory than what is now known as the province of Friesland, and it extended well into the present north-west part of Germany. This may explain why there is some resemblance between the Friesian and Holstein cattle, and as they were exported to a great extent from German ports this may explain why the name 'Holstein' cattle is so extensively known in America, and why the name 'Holstein-Friesian' is applied to the herd book which in the United States contains the records of the Friesian breed.

The province of Friesland, where the Friesian cattle are bred, is situated in the north-western part of the Netherlands, and the most important parts of this province with regard to cattle breeding form the rather wide seaboard in the north and west, and also the low moorlands which are found in the middle and near its southern frontiers.

The clay soils for the greater part, and the whole of the lower moorlands, consist of permanent pastures. The damp, mild climate is most favourable for a country where pastures occupy such a prominent position.

The rainfall varies between 24 and 32 in., and the average is very near the higher figure. The lowest temperature is reached in January, and although some very cold days are experienced, the average temperature for this month is only 35° F.

The farms in Friesland are, as a rule, not over 100 ac. in extent, and the farmhouses are mostly built with the living-rooms, cowhouse, and hay barn all under one roof.

Usually the cattle are turned out in the first days of May, but if there is a shortage of hay the young cattle may be turned out to the pastures somewhat earlier. According to the condition of the season, they are brought back to the byres towards the end of October or the beginning of November, and during the intervening period the cattle are dependent for their feed on the pastures, as no other food is given.

It is therefore evident that the methods in use in this branch of farming are very simple, and as the land does not require much attention the farmer has plenty of time to look after his cattle. He considers this as his principal and most important business. The fact that the farmer in Friesland has himself every opportunity to take such a great interest in all the details of the raising of his cattle may explain why he has succeeded in turning out such excellent animals. His herd, as a rule, is not very numerous; he seldom keeps more than thirty cows, together with a small number of calves, sheep, and pigs, and he is therefore in a position to know exactly all the good and bad qualities of every single animal.

The Friesian black-and-white milch cattle are not confined to the province of Friesland only, but are also found in all other provinces of the Netherlands. More particularly in the provinces of North Holland and South Holland an excellent type of the Friesian breed is raised.

As, however, the Friesian Herd Book does not extend its field of working outside the province of Friesland, all cattle raised in other parts of the kingdom are registered by the Netherland Cattle Herd Book (Nederlandsch Rundvee Stamboek). This herd book has, since its reorganization in 1907, adopted the name 'Black-and-White Holland Breed', and registers under this name all black-and-white cattle answering the requirements fixed for the pure breed. Although several authorities prefer the real name 'Friesian Holland', after a long discussion it was decided by the majority to leave the word 'Friesian' out.

Owing to the influence of the variety in the soil, and the different objects of breeding in several parts of the country, different types of the black-and-white cattle can be distinguished, but all belong to the original Friesian breed, and may be indicated, in distinction from the cattle in 'East Friesland' (Germany), with the general name 'Dutch Friesian' or 'Holland Friesian'. The object of the Netherland Cattle Herd Book is not only to promote the breeding of the pure-bred black-and-white Friesian-Holland cattle in all other provinces of the Netherlands but Friesland, but also to keep separate herd books for the two other distinct breeds in the Netherlands, viz.: (1) the Brown-and-White Maas-Ryn-Yssel breed, and (2) the Black-Whitehead Groningen breed.

The Friesian cattle belong to the large group of lowland races, and have a dominating black-and-white colour. There are some herds in existence which are distinguished by being white and light-brown, but most breeders endeavour to breed only the black-and-white.

According to the soil on which the cattle are raised, the Friesian cows are classified as Large, Middle-sized, and Small varieties. The first are found on the heavy clay soils, the Middle-sized are partial to the lower moorlands and to those districts where agricultural land is dominating, and the Small variety are found on the sandy soils.

To judge by their horns, the Friesian cows as well as the other Dutch breeds may be ranked among the Shorthorns. The horns advance horizontally and are bent to the front slightly downwards. It is this drooping and at the same time advancing direction of very short horns that are regarded as characteristic of good milking cows.

The Friesian cattle are developed by selection in the direction of milk production, but as that feature shows great variation it does not preclude the disposition to fattening. It depends to a great extent upon the manner in which the cattle are bred and reared.

The Friesland breeder considers a cow with the following external characteristics typical of the breed:—

A soft skin, as soft as that of a mole; large eyes; a black head with (small) white spot (star) on the forehead; the crown not too wide; horns fine, and bent to the front, with a small space between the points; nostrils wide and open; the neck rather thin than fleshy, widening itself with a graceful bend down to the chest. The chest must be well developed, so that the distance between the front legs is at least 8 in. The ridge of the back should form a straight line from the shoulder to the tail.

The fairly broad withers and the shoulders should merge with great smoothness into each other. The ribs should be long and smoothly bent; the loins join horizontally with the hind quarters; the flanks should not be large, and should be fairly closed. Seen from behind, strong, square hind quarters are shown, suggestive of the basis of a quadrangular pyramid, the apex of which is situated near the chest. The thighs are fleshy, and run in a straight line towards the *Achilles tendo.* The heels, like the shanks, are slightly bent, strong, and elastic.

The udder, which is extremely well developed, is joined with a smooth bend to the belly; the teats are well developed, but not too long. The milk vein, strongly swollen and very winding, runs well forward along the belly.

The hair marks should be as follows: A white, heart-shaped spot on the black forehead, black patches mingling with the white over the body, the division between the two colours being very sharply defined, there being no ground colour. The hair of the legs should be white, and the tail should be long.

All these qualities combined in one animal make the ideal Friesian cow. The weight of the calf when born is about 90 lb., and the following table shows how the increase of weight takes place as it increases in age:—

	Weight of cows.	Weight of bulls.
One year	660 lb.	770 lb.
Two years	990 ,,	1430 ,,
Three years ...	1320 ,,	1760 ,,
Four to five years ...	1430 ,,	—

These figures relate to animals in good breeding condition, and which are therefore not too fat.

The following are average measurements of a total of 120 cows taken by G. J. Van den Bosch, head inspector of the Netherland Cattle Herd Book, after the Dr. Lydtin system. The figures relate to cattle from the clay soils.

Length of trunk, 70 in.; width of chest, 18 in.; height of shoulder, 53¾ in.; width of hips, 22½ in.; width of pelvis, 20½ in.; height of rump, 54¼ in.; depth of chest, 29 in.; length of rump, 21¼ in.

Relative depth of chest when height of shoulder is taken at 100 is 53·7 per cent.

Relative width of chest when depth of chest is taken at 100 is 60·9 per cent.

Relative width of pelvis when width of hips is taken at 100 is 91·1 per cent.

The milk yield of the Friesian cow is sometimes very remarkable. In the best herds the average yield is, as a rule, well over 800 gal. per annum, when all cows together with those which have calved for the first time are included. On the good soils, however, where plenty of good grass is available, no herds are found where the average milk yield per cow and per annum goes below 650 gal. Older cows give as much as 1300 gal., and occasionally yields of 2150 gal. are officially recorded.

At international shows the Friesian cow always comes out first for milk and butter production, as, for example, at Chicago in 1883, at Amsterdam in 1884, and at St. Louis in 1904. At the latter show a Dutch cow gave 330·26 lb. of butter in 120 days.

It is a common practice to mention as a drawback of the Friesian cow that the milk is poor in quality. This is certainly not correct with regard to the present generation, for although there was some justification for this opinion some years ago there is none now, as, owing to the work of the control associations, a great improvement has taken place. Most of the creameries also pay for the milk according to the amount of fat, and this has induced dairy farmers to improve their herd with regard to the quality as well as to the quantity of the milk.

The control associations are combinations of from ten to twelve farmers, who appoint a qualified man to record the milk yield, and the amount of fat in the milk of each cow, of all the members once every fortnight. He also gives advice as to the best way of feeding. The farmer is therefore in a position to know exactly what return each individual cow is giving him, and by selling the bad ones and breeding with the better ones, he can gradually improve the productive power of his herd.

Marvellous results have been obtained in this way, and several herds can be shown where in some five years the average amount of butter fat in the milk has been increased by ½ per cent. As an instance may be mentioned the well-known herd of Mr. Kuperus at Marssum. Here, also, each cow is tested regularly every fortnight, and only the best cows are kept for breeding. The improvement of the herd went on steadily, as may be indicated by the following figures:—

The average amount of fat in the milk of the whole herd for the year 1897 was 3·15 per cent, and this increased to 3·28 per cent in 1898, to 3·39 in 1899, to 3·46 per cent in 1900, to 3·47 per cent in 1901, to 3·49 per cent in 1902, to 3·50 per cent in 1903, and to 3·52 per cent in 1904.

The highest milk production of a single cow of this herd was 1865 gal. in 329 days, and the highest record for butter yield was 615 lb. of butter in 317 days.

The official records of one Friesian cow which gave almost 6 gal. of milk with 5·9 per cent of fat on a single day are interesting. So also is a statement by Mr. Meedag, dairy expert for

TYPICAL FRIESIAN BULL

FRIESIAN COW

Friesland, who mentions in one of his reports a cow named 'Bos', which in 1900 gave 1640 gal. of milk with 4 per cent of fat in 370 days, and in the following year 1735 gal. with an average of 3·97 per cent of fat in 336 days.

From all this it is clear that the Friesian cow combines the merits of giving a large quantity of milk with that of giving milk of a good quality. The amount of fat varies from 2·5 to 4·5 per cent, but the average may be taken at from 3 to 3·2 per cent.

In Friesland the cows, as a rule, are served by the bull soon after they have been let into the pastures, and therefore they calve in the early spring, a period which extends from the middle of February until the middle of May.

The newborn calf is placed immediately in a separate stall, if possible in the hay barn, and the most careful breeders provide it with a muzzle and disinfect the navel, &c., so as to prevent the penetration of the bacillus which causes the so-called 'calf disease'. Moreover, this disease is also prevented by the giving of beestings. The calf gets this regularly three times a day during the first days of its existence, and this diet is followed up by full milk until the calf is fourteen to twenty-one days old. After this period the full milk is gradually replaced by butter- or skimmed milk. After some four or five weeks the calf does not get any more full milk, and it is then fed exclusively with butter- or skimmed milk, to which some linseed meal is often added. At this age the calf is usually taken into the pastures, and in addition to the grass, it gets for some time a beverage consisting of whey, to which some buttermilk, full milk, or skimmed milk is added, and generally some meal.

Simultaneously with the cows, or perhaps a little later, the calves are taken into the byres, and must live nearly all the winter exclusively on hay. Some farmers give additional feeding-stuffs, but this is an exception. In the spring they are turned out again, mostly in the company of a young bull, so that they calve when only two years old.

After calving, the cow gets, in addition to a liberal supply of hay, a certain quantity of feedingstuffs, varying from 2 to 9 lb. per day. The amount is regulated by the quality of the hay and the milk yield of the cow. Most Friesland farmers use principally linseed cake, which is considered by them as the most valuable additional food.

The farmer in Friesland does not keep his cattle very long, and as most animals are exported when from five to seven years old, older cows will rarely be seen.

Since the middle of last century, and particularly after 1870, the export of cattle from Friesland has become very important. The United States of America and Germany have always been the principal buyers, but lately the Friesian cow has been in great demand for practically all parts of the world, and Japan, for instance, has bought a great number of the best animals. In Germany, as well as in America, herd books are established to promote the breeding of pure-bred Friesian cattle. In America this has the name of Holstein-Friesian Herd Book; and East and West Prussia have separate herd books, with offices respectively at Königsberg and at Danzig.

In conclusion, something must be said about the herd book for Friesian cattle in Friesland.

The 'Friesian Herd Book' Association was established in the year 1879, but as pure breeding was already in existence in Friesland it was not considered essential to have a herd book for this purpose, but the object of the founders was, and still is, to establish a register for selected animals answering the most stringent external requirements. Even pure-bred descendants of registered cattle are not accepted for registration if their external qualities are not satisfactory, and for this reason the Friesian Herd Book will always contain only a small part of the total number of Friesian cattle in Friesland.

The two colours, black-and-white and light-brown-and-white, are kept strictly separate in the books, and animals with mixed colours are not accepted for registration.

No requirements are fixed for the productive power of the cows; but those owners of registered cattle who wish that figures for milk and butter yield should be recorded in the herd book are put under stringent control, so that the board of the Herd Book Association is in a position to guarantee the correctness of the figures which are recorded. As almost all the members of the herd book are now under such control, the Friesian Herd Book is not only a guarantee for the purity of the breed, but it is also of great value for the guidance of those buyers who wish to know what result they may expect with regard to milk and butter production when breeding with the animal which they intend to buy.

The herd book is open to inspection to everyone who applies to the secretary at the Landbouwhuis at Leeuwarden. [J. J. L. V. R.]

Friesland Horse.—The Friesland, or, as he is usually styled, the East Friesland, horse is one of the most valuable of the Continental breeds, dividing popularity with the Oldenburg and Holstein varieties, which, like the subject of this description, are frequently met with in this country. The district in which the East Frieslands are bred extends southwards as far as Osnabrück, and from Holland on the west to Oldenburg on the east, where their territory adjoins that of the even more famous Oldenburgs. There can be no doubt at all regarding the antiquity of the breed, as a race of horses was well known and highly appreciated in the neighbourhood as far back as the Middle Ages, but the old type has become greatly modified through the many crosses to which the breed has been subjected. Such changes were only what could have been expected when the alteration in the existing designs of vehicles and the improvement of the highways are remembered, and it must readily be admitted that the utmost credit is due to the breeders whose good judgment has resulted in the production of so valuable and fine-actioned a harness horse.

In modern times the breed has been fostered

by a society known as the Agricultural Head of East Friesland, who every spring carry out an official inspection of the three-year-old stallions, whilst in the autumn of each year the adult horses are carefully gone over, no stallion being allowed to be used for stud purposes in the district unless he has been passed by the inspectors, not merely as sound, but as suitable in appearance to discharge the duties of a high-class harness horse and to produce stock of that description. Nor do the brood mares escape a similar ordeal, as none are admitted to the stud book of the breed until they have been inspected and passed, whilst valuable prizes are awarded annually to such mares as conform to the conditions as regards soundness, action, and good looks, and have in addition produced two foals which have been accepted for registration in the stud book. It is not surprising, therefore, that the results have been the establishment of a very high-class harness horse of the Hackney type, but of a far better, or at all events more saleable, colour, as the East Frieslands are mostly of a good shade of bay or brown. They are big, upstanding horses, too, with plenty of bone and substance about them, and as they move well, though possibly they do not possess the dash and immense freedom of a high-class Hackney, they are greatly appreciated by those who use heavy carriages such as landaus. In fact, there is not a capital in Europe where the East Friesland Horse is not to be seen, though doubtless his identity is not recognized by many people, even if it is known by his owner, who has probably purchased him under the impression that he is not a foreign horse. [V. S.]

Fringe Tree. See CHIONANTHUS.

Frit Fly, a small black fly very destructive to cereal crops. See OSCINIS FRIT.

Fritillaria, a large genus of the Lily family, of which the Snake's Head (*F. meleagris*) and the Crown Imperial (*F. imperialis*) are familiar in gardens. They all have a perennial bulbous rootstock, annual stems, and nodding bell-shaped flowers, and they grow freely in the ordinary border, flowering in spring. They develop offsets which may be used for propagation. Some of them are suitable for the rock garden, as they have short stems, and if planted in tufts they have a pretty effect when in flower. The Crown Imperial grows to a height of from 3 to 4 ft., and has a crowded whorl of orange-coloured or yellow flowers. It is a good plant for the wild garden. Another large-flowered species is *F. latifolia*, of which there are many garden varieties, their colours being purple, lilac, yellow, or variegated. *F. recurva* has bright-red flowers. [W. W.]

Frog Fly.—A small brightly-coloured hemipterous insect which infests the potato crop. See EUPTERYX.

Frogs and Frog Farming. — The various species of frogs belong to a class of cold-blooded vertebrates known as Amphibians (see arts. ANIMAL KINGDOM and COLD-BLOODED ANIMALS). In this class are also comprised the toads, which, although of similar general appearance and habits, are distinguished from the frogs by several important features. Frogs have a smooth skin, teeth in the upper jaw round pupils, long, well-developed hind limbs, and perfect webbing between the toes. Toads have wrinkled skins covered with wartlike glands, an imperfect web between the hind toes, and have shorter hind legs than frogs.

Although they multiply at an extraordinary rate, the numbers of adult frogs are always kept within limits by the heavy toll which is levied on their ranks by water fowl, weasels, foxes, rats, pike, snakes, storks, &c.

Two species are of common occurrence in Europe, viz. the common Brown or Grass Frog (*Rana temporaria*) and the Edible or Green Frog (*R. esculenta*). The latter is found in Britain only in a few of the eastern counties of England, particularly in Norfolk, where it was probably introduced from the Continent in consequence of a demand for them by certain London hotels of epicurean pretensions. The edible frog is almost wholly aquatic. The common frog is more terrestrial in habit, although it also swims well. It is most frequently found in moist situations favoured by the numerous species of insects and their larvæ on which it feeds. Moisture is essential to all species of frogs, respiration being partly cuticular. Both species are used for culinary purposes on the Continent, but the edible frog proper, on account of its somewhat larger size and superior flavour, is preferred.

Attention has been directed, by a growing demand for frogs as an article of food in the United States, to numerous edible species occurring in that country. Of these the following are important commercially. The Spring or Leopard Frog (*R. virescens*) is distributed all over the United States. It has been advocated as especially suitable for artificial culture on account of its gregarious habits, and because it is largely terrestrial in habit. It is a small, olive-green frog with dark spots. The Green Frog (*R. clamitans*) is accounted of superior quality and flavour. It is entirely aquatic, of a uniform dark-green colour, and occurs chiefly in the eastern States. All the foregoing species average about 3 in. in length. The Bull Frog (*R. Catesbiana*) is the largest edible species, being from 7 to 9 in. long, exclusive of the legs. It is widely but comparatively sparsely distributed in the United States and Canada. Relatively high prices are offered for this species, and it is probable that more profitable returns could be obtained from it under artificial culture than from any of the others.

Interesting statistics and information on the subject of the propagation and marketing of frogs in America are furnished in the report of the United States Fish Commission, 1897. According to this report, the annual catch of frogs in the United States is estimated at 1,000,000, worth $50,000 to the hunters, and $150,000 to consumers. These figures are now much exceeded, and the evidence shows an annually growing business. In New Orleans alone—one of the large distributing centres—about 1,000,000 frogs were handled in 1907.

With regard to the possibility of artificial culture, the following statement is made in the

report: 'While at present it would perhaps be advisable to limit practical attempts at frog culture to stocking natural waters with paired breeders, experiments in artificial methods should not be abandoned. There seems no reason why methods similar to those at present pursued in fish culture may not eventually be successful in the case of frogs.'

Frog farming as a definite occupation is pursued in a few isolated instances, but as a rule the business is only an adjunct to ordinary farming, and frog farms so-called are simply natural ponds and marshes where precautions have been taken to restrain and foster the wild stock present. One frog farm in Ontario has been running for twenty years. In 1895-6 this farm yielded 5000 lb. dressed frogs' legs for market, and 7000 living frogs for scientific purposes. Systematic experiments in scientific frog culture were begun by the Department of Fisheries, Pennsylvania, in 1899. After repeated failures, a degree of success was attained in 1904 when 40,000 young frogs were developed from wild eggs. The following practical conclusions may be drawn from these and other experiments.

1. Ponds for tadpoles should be at least 60 ft. by 20 ft., and for growing frogs not less than ½ ac. Three acres under favourable circumstances are capable of yielding a moderate income.

2. The ponds must have a soft mud bottom in which the frogs may pass the winter.

3. The eggs are collected and placed on a netting near the surface in a pond to which the frogs are not allowed access.

4. It is an advantage to have several ponds, so that tadpoles, young frogs, and frogs which are nearing a marketable size may be kept separate. Otherwise loss will occur from the older frogs devouring tadpoles and young ones. Overcrowding is also fatal to success.

5. Water lilies and other aquatic plants should be provided to attract insects. No adequate substitute for the natural food of frogs has so far been discovered. This factor necessarily limits the scope of the industry.

Contrary to the prevailing belief, no such systematic attempt at the artificial breeding of frogs on a commercial scale has been recorded in Continental countries. Private effort has indeed been directed to the propagation of snails (see SNAIL FARMING), but frogs are regarded in France, as in Britain, as a more or less epicurean dish, and the demand is amply satisfied by the supplies of wild frogs. These are hunted by the peasantry, who stick them with steel-pointed staffs by the sides of ponds and streams. The thighs are the chief parts used, and in the hands of a skilful cook these are turned into a by no means disagreeable ragout, or into appetizing morsels of a flavour slightly resembling stewed rabbit when fried in butter and encrusted in bread crumbs.

The frog is regarded as a useful ally of the gardener, and is frequently employed by them for the destruction of snails in greenhouses. In the garden of the Rouen entomological laboratory, snails were completely exterminated in 1891 as the result of introducing 100 toads and 90 frogs. The edible frog is charged with devouring large quantities of fish spawn in France. This does not apply to the common species, which is more terrestrial in habit. [J. R.]

Frost—Effect on Forest Trees.—Trees are frequently affected by frost either on account of its exceptional severity or the unseasonable period at which it occurs. Frosts of ordinary intensity occurring between October and March seldom injure the common forest trees found in Great Britain, as the majority withstand temperatures down to or slightly below the zero of Fahrenheit with impunity, provided that their shoots are in a dormant and thoroughly ripened condition. Species most susceptible to damage from severe winter frosts are evergreens—both coniferous and broad-leaved—indigenous to the warm temperate zones, as, for instance, *Pinus insignis*, *P. maritima*, *Cupressus macrocarpa*, laurels, hollies, &c. The deciduous species are occasionally damaged by the destruction of badly ripened or immature shoots of the previous season—an injury frequently occurring with Spanish Chestnut, Oak, locust tree, &c., especially when growing in damp and low-lying situations conducive to late autumn growth.

During severe winters several species of trees are liable to 'frost shake', due to the splitting of the stem in a radial direction. This injury is assumed to result from the more rapid contraction of the outer portion of the stem, and the loss of cohesive strength in the timber following the freezing of the water in the wood. Ash, Oak, Beech, Elm, &c., are more liable to this injury than conifers or species with fine medullary rays.

Late spring frosts occurring in April and May are usually more injurious to trees than winter frost. At this season, growth of leaf and stem is in full activity, and the freezing of sap in the most recently formed cell tissue is usually followed by the death of the latter. Species most readily injured are Ash, Beech, Silver Fir, Oak, Spanish Chestnut, &c., while Elm, Sycamore, Birch, Alder, Poplar, Willow, &c., withstand night frosts in April and May without serious injury. Trees growing on flat, low-lying land, in hollows in which the colder air accumulates, or on aspects favouring the sudden thawing of the frozen plants, are invariably liable to frost injury, while young trees and seedlings suffer more than those with crowns well above the surface of the soil. [A. C. F.]

Frost—Effect on Soil. See SOIL.

Frosted Roots.—The liability of 'roots' (turnips, mangels, potatoes, &c.) to decay rapidly, after once being frozen, renders their storage and utilization in cold climates a matter of considerable difficulty.

The frozen roots are not in themselves dangerous to use, except that when consumed in large quantities, especially by animals with rather weak digestion, they are liable to set up chill and consequent derangement of the digestive organs. Sheep are particularly liable to be affected in this way. The great drain upon the food to supply the heat required to thaw the

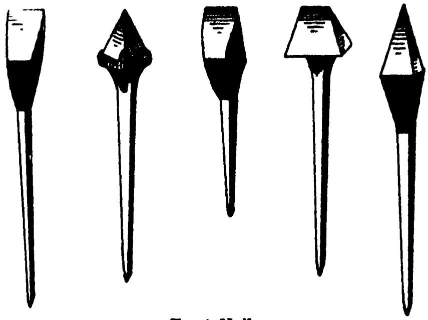
consumed roots and warm them up to the body temperature is, however, a further grave disadvantage.

So long as the roots remain frozen they undergo practically no change, but on thawing they commence to rot rapidly, and hence, like other putrefying materials, are liable to give rise to products of poisonous character, and can only be used as food at grave risk. It is therefore practically impossible to store frosted roots in the raw condition, and if the quantity is not too large they should be fed at once, with due precautions against overfeeding with large quantities. The only feasible plan to avoid total loss is to convert them, sliced and mixed with chaffed hay and straw, into an acid silage.

We cannot yet state the precise nature of the changes effected by the freezing of the roots. The explanation still commonly put forward, although long ago discredited, attributes the deterioration of the root to general disruption of the cells by the expansion accompanying the formation of ice in the cell. It was clearly proved, however, by H. Müller (1880-6), to whom we are indebted for much light on the subject, that the formation of ice takes place not inside the cells but in the spaces between the cells, the ice crystals growing there at the expense of the water of the cell sap, which passes steadily through the walls. Rupture of cell walls may occur to some extent, but this is not the ordinary cause of the death of the root. It was shown by Müller that the root juices could be cooled down much below their real freezing temperature without ice formation taking place, but that, as with all other 'supercooled' liquids, a temperature is eventually reached at which ice forms with great rapidity. It is most probably this sudden withdrawal of large amounts of water from the protoplasm which causes it to lose its vitality. Whether this be the true explanation or not, it is a well-established fact that the protoplasmic lining of the cell walls after freezing is far more permeable to dissolved substances, even indeed to those of colloidal or comparatively indiffusible nature, than in the normal condition. Hence, when the roots thaw, the ingredients of neighbouring cells will mix more readily, and the various ferments (enzymes), being no longer confined to individual cells, will now have free play in reducing the more complex carbohydrates and proteins ('albuminoids') to simpler forms, which then rapidly undergo fermentation by bacteria, moulds, and other micro-organisms. When the roots are only slightly affected by frost, they can be saved with greater certainty if allowed to thaw gradually, than if rapidly warmed.

In this connection, although the phenomenon is not attributable to actual freezing, reference may also be made to the development of sweetness in potatoes when kept for several days at temperatures near the freezing-point. The explanation has been given by Müller, who found that sugar is continually being produced from starch in the potato even at temperatures well above the freezing-point, but the sugar thus produced is at such temperatures subject to oxidation in the respiration of the plant, and therefore cannot accumulate. In the neighbourhood of the freezing temperature, however, respiration practically ceases, but sugar-formation continues, and hence the sugar tends to accumulate, at a rate which increases with the water-content and is different with different varieties. This explanation finds support in the fact that when these sweet potatoes are stored at a rather higher temperature they rapidly lose their sweetness and regain the normal flavour. [C. C.]

Frost Nails.—Frost nails are a useful expedient for preventing horses from slipping on



Frost Nails

frozen roads, and are frequently resorted to in this changeable climate. They answer the purpose for a journey or two, and save the strain and wear and tear of roughing. They are made in various designs, as shown in the illustrations, but in the best-managed stables horses are shod a little wider at the heel, and screw holes prepared for the insertion of frost cogs, which are removed when no longer needed, and the thread saved by a level plug in the place of the cog. [H. L.]

Frothy Cream.—The cause or causes of frothy or sleepy cream may be sought for in the realm of bacteriology, but the source or sources from which the ferment may have come cannot always be located. Winter feeding of cows in an advanced period or stage of lactation is a cause to which sleepy cream has often been ascribed. And it is probably correct so to allot the blame, at all events in part; but the active cause is bacterial, all the more active because of the condition of the cow and of the milk she yields. This last is a point involving deterioration of quality in the cream; but it is a passive, not an active cause of the condition known as 'frothy' in cream. It is a condition in buttermaking corresponding with that of 'floating curd' in cheesemaking. It has been found that an addition of cows recently calved tends to sensibly mitigate the evil, inasmuch as the quality of the cream is raised, and it is therefore less open to the intrusion of yeasts, which induce and promote the fermentation, whose effect is seen in frothy cream or in floating curd, as the case may be.

The most effective remedy against frothy cream is scalding the cream to destroy the bacterium that does the harm, and, when cooled down to a normal point—say 60° F.—adding an infusion (called 'a starter') of the lactic-acid bacillus, which alone can ripen cream properly

and checkmate the action of other ferments during the ripening. [J. P. S.]

Frozen Meat.—Meat which is imported into the United Kingdom from distant countries has to be reduced in temperature, so that it will be immune from putrefaction. It has been found that the application of cold to all classes of meats enables them to be preserved for an indefinite period, and also permits of their being carried on board ship through tropical temperatures. It was in 1879 that two Glasgow men named Bell and Coleman first of all installed a cold-air refrigerating machine on board a steamer called the 'Strathleven', so as to try the experiment of bringing frozen meats from Australia. The experiment was entirely successful, and, as a consequence, frozen mutton and beef have been imported from Australia, New Zealand, the River Plate, and the United States in increasing quantities ever since.

It is interesting to notice the quantities of beef and mutton which have been imported into this country from all sources during the last three decades:—

	Beef.	Mutton.
1887	874,248 cwt.	783,114 cwt.
1897	3,588,010 „	3,292,298 „
1907	6,033,736 „	4,617,743 „

It will thus be seen that the increase in the frozen-meat trade since its start has been enormous—so much so, indeed, that it has very largely displaced home meats in our largest dead-meat market at Smithfield, London. The gradual increase as shown in that market is concisely set forth in the following table, and it will be observed that the gradual increase in foreign supplies is coincident with the gradual decrease in the supplies of home meats:—

Year.	Weight of supplies marketed.	Increase on previous period.		Origin or sources of supplies, in terms per cent.			
				'English killed and United Kingdom Productions	Imported productions: chilled or frozen.		
		Weight.	Rate per cent.		North and South American.	Australasian.	Continental.
	Tons	Tons.					
1869	127,981	—	—	97·7	*Nil*	*Nil*	2·3
1877	197,631	69,650	54·4	89 0	7·4	*Nil*	3·6
1887	259,383	61,752	31·2	77·5	9 5	5·8	7·2
1897	391,707	132,324	51·0	47·9	18·8	20·3	13·0
1907 .	417,057	25,350	6·4	36·6	24·6	25·7	13·1

The temperature at which frozen meats are imported varies from 5° F. to 22° F., and it is considered that at such low temperatures there is *no possibility of any deterioration.* The reason for the extremely low temperature, however, is not quite apparent, except it is on the theory that as the juices of the meat are converted into ice, then it is advantageous to make the ice so formed as hard as possible, and this can be obtained by a continuously low temperature.

The process of cooling mutton, beef, and other goods which are brought into the United Kingdom in the frozen state is very simple. The carcasses are first of all hung up, so that the animal heat is allowed to evaporate, after which they are put into the chill room at a temperature of about 35° F., and are kept at that temperature for ten or twelve hours, or such a period as will enable the whole of the meats to be chilled throughout. When that has been accomplished, the carcasses are then placed in the freezing chamber and are gradually lowered in temperature until they reach the extremely low temperatures mentioned. An average temperature would be 20° F.

In recent years it has been found that the purely frozen meats have not realized the same prices as meats imported at a higher temperature; and this has given rise to a trade between the United States, Argentina, and some other countries, and the United Kingdom, in what is called 'chilled' beef, and which is brought overseas at a temperature of 28° F. The chilled meats are certainly more marketable than those *which are frozen, owing to the fact that at the* moment of freezing there is a slight expansion in the ice, which is formed out of the liquid contents of the muscles, and this ruptures the surrounding cells, so that when the thawing-out process begins, the disintegration of the meat is very unsightly. Micro-organisms also have a more ready access to the ruptured tissues, and decomposition is therefore more rapid in frozen meats than in any other.

It is essential that frozen meats, to be of acceptable quality, should present a nice appearance, and as the ordinary temperature of a shop is 30° to 40° higher than the temperature of these meats, it will be readily understood, that if chilled meats can be kept a longer time in a shop without disintegration than frozen meats, they will be much preferred by the meat purveyor.

In the handling of all kinds of meats it must be remembered that muscular tissue is a very bad conductor of heat, and when meat has been frozen and afterwards thawed the surface may be altogether decomposed, and the interior will remain in a hard state. This is entirely due to the fact of the non-conductivity of the muscles, which is further illustrated in the cooking of an ordinary joint, when, after a prolonged exposure to heat, it may be found that the interior

portion of the muscular tissue is hardly cooked at all, and the outside may be in an overcooked condition; but this does not apply to the meat which is near to the bones, as, curious enough, these form a perfect conductor of heat, and consequently the meat adjacent to them is cooked quicker than the thicker portions.

The subject of the freezing of meats and the method by which this is attained is described under the art. REFRIGERATION. [L. M. D.]

Frozen Milk.—Milk may be intentionally frozen for the purpose of sending it long distances, as, for instance, when imported to the English market from Holland or other countries. *It may also become naturally frozen if kept exposed during very cold weather. Milk will not begin to freeze till the temperature has fallen below 31° F. If left to stand even in very* great cold it will not freeze to a solid block; but a coating of ice will be formed round the sides and at the bottom and top of the vessel containing it. If cream has risen to the surface, this may be frozen, and will contain more fat than the liquid portion of the milk; but with this exception the frozen part will always be of much poorer composition, both in fat and solids not fat, than the part of the milk which remains liquid. This fact constitutes a possible danger to the seller of milk; for if he sold the liquid portion first, the remainder, when melted, would have the composition of watered milk, and if sold to an inspector might result in a prosecution under the 'Food and Drugs Act', even if the milk had been originally of good quality. The lower the temperature to which the milk has been exposed, and the higher the percentage of ice, the more dilute will be the liquid obtained by melting this ice. If some cream has also risen, the frozen skim milk round the sides and bottom of the vessel will be poorer still. It should be remembered that the bacteria in milk are not killed by freezing, but are only rendered dormant while the low temperature lasts, and will renew their activity as soon as a more favourable temperature makes this possible. This danger constitutes a strong argument against imported frozen milk, since many pathogenic germs might be preserved by the ice from the action of their natural enemies, the lactic bacteria, which would not grow at the low temperature. [J. Go.]

Fruit, Cultivation of. See APPLE, PEAR, &c., also 'Fruit Farming' under FARMING, SYSTEMS OF.

Fruit Farming. See under FARMING, SYSTEMS OF.

Fruit Room, a place specially set apart for the storing and keeping of fruit. In many places there is a room or shed which, by a little alteration and fitting up, would provide the conditions requisite to success (see FRUIT STORING); but where a considerable orchard is maintained it is usually preferable, and in the end most economical, to provide a separate structure. The site should be dry and airy, an eastern or northern aspect being the best, and as an excess of moisture is disadvantageous, it should not be shut in by trees, and may require to be drained. Fluctuations of temperature are what have chiefly to be guarded against, and the provision of hollow walls, or an inner casing of matchboarding so placed as to create an air cavity, are the best precautionary methods. There must be means of ventilation, preferably in the roof, and while darkness is best for the fruit, it is best to be able to admit light to permit of examination. A little artificial heat may be required when the weather is severe, and this is best provided by hot-water pipes, which it is often possible to connect with the boiler of a greenhouse or some other adjacent building. A concrete floor is the best, and a tiled or thatched roof. It is usual to have a central walk, and tiers of shelves on either side. Those formed of deal batten are the best, and as they permit of the fruit being easily inspected, it is advantageous to have movable or sliding trays. Illustrations of a cheap and effective fruit room, together with some details of its construction, and an illustration of Orr's storing trays, accompany the art. upon APPLES. [W. W.]

Fruit Rot. See APPLE—PARASITIC FUNGI, and CHERRY—PARASITIC FUNGI.

Fruit Storing.—The proper storing of fruit is a matter of importance wherever a few orchard trees are cultivated, while in the case of the commercial grower upon a considerable scale, his profits would undoubtedly often be greater if he devoted more attention to it. Neglect to provide proper storage accommodation is to a great extent responsible for the crowding of the markets early in the season with English apples, whereas if late-keeping kinds were more extensively grown, and offered for sale in prime condition after Christmas, the returns to the grower would be much more satisfactory. It is not at all difficult to keep apples and pears of suitable varieties until April or even later.

The conditions most essential to the successful keeping of fruit are: a judicious selection of the varieties to be kept; soundness of condition when they are stored, supplemented by frequent examination afterwards and the removal of all specimens which exhibit symptoms of decay; the maintenance of a steady cool temperature approximating to 40° F.; the exclusion of light, and means for ventilating when required. These are not difficult to provide, and an attic is, in particular, often used with conspicuous success; for fruit storing upon a considerable scale, however, it is best to erect a building devoted to that use alone (see FRUIT ROOM). Choice apples and pears are disposed in a single layer upon wooden shelves, but they will also keep very well in barrels or in drawers. Under these conditions it is best to isolate each fruit. The principal difficulty is to keep the temperature low in autumn, and afterwards to exclude frost, which induces decomposition. It is accordingly advisable to have the means of providing artificial heat in case of very severe weather, but a warm, dry atmosphere causes shrivelling. Cleanliness, and the absence of anything that might taint the fruit, are also points of considerable importance. It has, for example, been suggested that mushrooms might be raised in the fruit store, but there would be a great risk of spoiling its contents. Pears

are more difficult to keep than apples; they should be permitted to mature very slowly.

Bunches of grapes intended for storing are cut with a sufficiently long piece of wood to reach nearly to the bottom of a bottle containing water, to which a small piece of charcoal is added to keep it fresh. They require the conditions requisite to the ordinary fruit room, but are best suited by a drier atmosphere. Soft fruits, such as strawberries, raspberries, and currants, may be kept in good condition in a fruit room for a few days, but their preservation in a fresh state for any length of time is difficult. For this they must be picked before they are quite ripe, and even so they soon lose their fresh, inviting appearance. Plums can be stored for a week or two, some of the varieties improving in flavour when kept a little while. The perfect condition in which apples, &c., reach our shores from countries as far distant as Tasmania affords a valuable object lesson in the proper handling, grading, and preservation of fruit. [W. W.]

Fruit-tree Bark Beetle. See SCOLYTUS RUGULOSUS.

Fruit Trees, Spraying of. See SPRAYING.

Fuchsia, a genus of about fifty species of shrubs of various habit, some of them growing almost into trees, whilst others are small trailers. Only a few of them are cultivated in gardens, the popular sorts grown being hybrids of garden origin, in the breeding of which *F. macrostemma* (*coccinea*) was largely used. This was introduced from Chile in 1790. There are now races of it with large flowers, single and double, which are grown principally in greenhouses and cottagers' windows; others, again, with smaller flowers, are hardy in the warmer parts of the British Isles, being grown in borders, &c., outside. In Cornwall and the south of Ireland fuchsias may be seen with stems 6 in. thick. In the colder parts of this country such sorts as *F. globosa*, *F. corallina*, *F. gracilis*, and *F. Riccartoni* are grown in the open air, where, although their stems are annually killed by frost in winter, the plants survive, growing and flowering vigorously every summer. Messrs. Lemoine & Sons, of Nancy, have raised an improved race of these hardier fuchsias which is popular with growers of summer-bedding plants. All fuchsias are easily propagated from cuttings. In winter the plants may be stored in a dry shed, the stems retaining sufficient vitality to enable them to start into fresh growth on being placed in a little heat and moisture in spring. [W. W.]

Fucus, a genus of Algæ or seaweeds generally known as wrack or seawrack. One of them, the bladderwrack, is commonly met with on our shores. See ALGÆ.

Fuels.—The term 'fuel' is applied to substances which may be burned by means of atmospheric air with sufficient rapidity to evolve heat capable of being applied to economic purposes. Fuels may be divided into (1) natural fuels, and (2) prepared fuels. Of the former class we have wood, peat or turf, lignite or brown coal, bituminous coal, anthracite, petroleum, and natural gas; and of the latter we have compressed fuels, dried fuels, carbonized fuels (coke and charcoal), and fuels obtained by the distillation or incomplete combustion of natural fuels—gasolene or petrol, benzine or naphtha, kerosene, alcohol, paraffin, coal gas, Mond, Dowson, and other producer gases.

The value of a fuel depends upon the amount of carbon and hydrogen it contains. In the complete combustion of a fuel the carbon combines with oxygen to form carbonic acid (CO_2), and the hydrogen with oxygen to form water (H_2O), and for each pound of carbon thus consumed sufficient heat is generated to raise 14,500 lb. of water through 1° F.; and similarly for each pound of hydrogen consumed 62,032 Fahrenheit heat units are produced. If, however, the supply of air or oxygen be insufficient for perfect combustion, some carbonic oxide (CO) will be produced; and for each pound of carbon thus combining with oxygen to form CO, only 4452 units of heat will be generated. The following table gives the weight of oxygen and the weight and volume of air theoretically required per pound of combustible, together with the heat generated for the various constituents of fuels:—

Combustible.	Products of Combustion.	Per lb. of substance burnt.			
		lb. of oxygen required.	lb of air required.	Cubic feet of air required at 62° F.	Thermal units generated.
Hydrogen (H)	Water (H_2O)	8·0	34·8	457	62,032
Carbon (C)	Carbonic oxide (CO)	1·33	5·8	76	4,452
,, ...	,, acid (CO_2)	2·66	11·6	152	14,500
Methane (CH_4)	Carbonic oxide and water ...	4·00	17·4	229	23,513
Ethylene (C_2H_4) ...	,, acid and water ...	3·43	15·0	196	21,343
Carbonic oxide (CO) ...	,, acid	0·57	2·48	33	4,325
Sulphur	Sulphurous acid gas (SO_2) ...	1·00	4·35	57	4,032

The calorific value of a fuel, or the heat generated by the complete combustion of 1 lb. of it, is measured in two ways: either by the number of pounds of water which it can raise through 1° F., or by the number of pounds of water at the temperature of 212° F. it can convert into steam at the same temperature.

Suppose C, H, and O are the weights of carbon, hydrogen, and oxygen respectively contained in a pound of a given fuel, and suppose further, as

is usually done, that the oxygen and a portion of the hydrogen exist in a state of combination in the form of water, so that the *disposable* hydrogen will be $= \left(H - \frac{O}{8}\right)$, and the calorific value of the fuel, therefore, will be:

$$h = 14{,}500\,C + 62{\cdot}032\left(H - \frac{O}{8}\right)$$

$$= 14{,}500\left\{C + 4{\cdot}28\left(H - \frac{O}{8}\right)\right\} \text{ in Fahrenheit units, or}$$

$$E = \frac{14{,}500}{966}\left\{C + 4{\cdot}28\left(H - \frac{O}{8}\right)\right\} \text{ in evaporation units,}$$

and the number of pounds of air theoretically needed for complete combustion will be:

$$A = 11{\cdot}6\,C + 34{\cdot}8\left(H - \frac{O}{8}\right),$$

and the volume at 62° F. will be:

$$V = 152\,C + 457\left(H - \frac{O}{8}\right) \text{ cu. ft.}$$

In practice, however, the amount of air required is from one and a half to two times the theoretical amount thus calculated.

It has been found, however, that the above formula for calculating the heating value of a fuel gives results which are from 1·5 to 10·5 per cent too low, so that about 6 per cent should be added, on an average, to the calculated values.

Another formula is now coming into use, one which is supposed to give more correct results than the above, and this is:

$$h_1 = 14{,}500\,C + 62{,}032\,H - 5400\,(O + N),$$

where N is the weight of nitrogen present in a pound of the fuel.

1. Natural Fuels.—*Wood.*—Air-dried wood contains about 40 per cent of carbon, 40 per cent of chemically combined water, and 20 per cent of hygroscopic water, and has a calorific value of about 6400 Fahrenheit heat units. Air-dried woods containing 20 per cent of moisture, and having a specific gravity greater than 0·55, are classed as hard woods; with a lower specific gravity they are classed as soft.

Peat.—Peat or turf is an agglomeration of decayed vegetable matter produced by the slow decay of plants under conditions in which the supply of air is limited, and is very widely distributed throughout the world. In Ireland the peat area covers one-seventh of the island, and in Great Britain it covers about six million acres, with an average depth of 12 ft. Good air-dried peat contains about 46 per cent of carbon, 1·5 per cent of *disposable* hydrogen, 27·5 per cent of chemically combined water, and 25 per cent of hygroscopic water. On account of its great bulk as compared with coal, and the high percentage of water it contains, peat has not hitherto been extensively used as a fuel, though many attempts have been made to prepare it in a form more or less suitable for the purpose.

Lignite.—The lignites occupy an intermediate position between peat and true coals, and are of four distinct types: (1) Fossil wood or brown coal, the lignite of the Germans; (2) earthy lignite, without structure and earthy in fracture; (3) conchoidal lignite (with no distinct vegetable structure); and (4) bituminous lignite, a black shiny fuel having an earthy fracture and used more for the production of tar than as a fuel.

The lignites burn with a smoky flame, and their calorific values vary considerably. In Fahrenheit heat units the mean calorific value of the four varieties are: (1) 8500, (2) 10,000, (3) 11,700, and (4) 12,000.

Coal.—Coals, properly so called, are distinguished from the lignites by their deep-black streak, great density, and friability; and when subjected to dry distillation they yield a greater amount of carbonaceous residue. Coals have been classified by Gruner into: (1) Non-caking coals with long flames, (2) caking, long-flame gas coal, (3) *bituminous or furnace coal, (4) caking coals with short flame, (5) anthracite coals. In these coals the percentage of hydrogen present does not vary much, and averages about 5 per cent;* the carbon, however, varies from about 77 per cent, on an average, for those of the first-class, to about 91 or 92 per cent for those of the last division, and their calorific values from about 13,500 to about 15,300 Fahrenheit heat units.

Anthracite.—This is often called hard coal, and is the ultimate product of the conversion of vegetable matter into coal. It was formed at high temperature and under great pressure, and has little, if any, volatile matter or hydrocarbons. It is hard and lustrous, with a vitreous fracture; is not easily ignited; burns with a short flame and little or no smoke, and with an intense heat; contains from 93 to 95 per cent of carbon, and has a calorific value of about 15,300 Fahrenheit heat units.

Liquid Fuel, Petroleum.—Liquid fuels are hydrocarbons and are called oils. Oils of animal origin and vegetable oils extracted from seeds or other products are used as fuels only to a very limited extent. The chief natural liquid fuel is the mineral oil, or petroleum, obtained in large quantities from the oil wells of Baku and Pennsylvania, and from many other sources.

In its crude state, petroleum contains, on an average, 85 per cent of carbon, 13 per cent of hydrogen, and 2 per cent of oxygen and impurities, and has a calorific value of about 20,000 Fahrenheit heat units.

2. Prepared Fuels.—*Charcoal.*—Charcoal is the carbonized residue obtained on the dry distillation of wood, and is prepared either in the open air or in closed chambers. It is black, porous, burns without smoke, and, in separate pieces, without flame.

Coke.—Coke is the carbonized residue obtained on the dry distillation of coal containing hydrocarbons in a retort or oven. It is usually dark-grey in colour, is porous, hard and brittle, and has a slight metallic lustre. It commonly contains 80 to 93 per cent of fixed carbon, from 17 to 5 per cent of ash, and from 2 to 3 per cent of impurities.

Liquid Fuels.—Crude petroleum from the wells, when subjected to a series of fractional distillations, yields several varieties of liquid fuel: (1) Gasoline, (2) benzine or naphtha, (3) kerosene, (4) higher paraffins. Other liquid

fuels are also used, such as crude shale oil, obtained by the destructive distillation of bituminous shale at 600° to 700° F., and Scotch shale oil, which, when subjected to practical distillation, yields benzine or naphtha, kerosene, paraffin, &c.

Gaseous Fuels.—Ordinary coal or town gas and various kinds of producer gases are used as fuels both for power and heating purposes. Coal gas is obtained by the destructive distillation of bituminous coal in closed retorts, which are heated externally by a coke fire, the fuel used for effecting the distillation being quite distinct from the charge undergoing distillation. On the other hand, producer gas is obtained by the distillation of coal in a closed furnace, in which the distillation is effected by using a part of the heat of combustion of the 'charge'.

The heating value of coal gas varies from 620 to 800 Fahrenheit heat units per cubic foot, while that of the various producer gases used in practice, viz. Dowson gas, Mond gas, Duff gas, &c., is only about a fifth of this. For further information of gaseous fuels see GAS AND GAS PLANTS. [H. B.]

Fuller's Thistle. See TEASEL.

Fumaria, the generic name for a group of plants which includes the Common Fumitory. See FUMITORY.

Fumigation.—To fumigate meant originally to treat with smoke. It now means to treat with any fume or vapour, and the term fumigation is specially applied to the treatment of substances with vapours or gases, in order to disinfect them by destroying noxious germs. Fumigation is also made use of in destroying certain kinds of noxious insects.

DISINFECTION.—Various vapours are made use of in disinfecting by fumigation. The fumes produced by burning sulphur, which consist of sulphur dioxide gas, have long been used for disinfecting rooms after infectious disease. Sulphur fumes are probably the best known and most extensively used of disinfecting vapours. They have been officially used and recommended in our own and other countries by sanitary authorities. In disinfecting with sulphur, about 1½ lb. of sulphur should be burned per 1000 cub. ft. of space. Liquid sulphur dioxide is now largely used instead of burning sulphur. It is more simple to use, and more certain in its action. It can be purchased made up in tins or syphons ready for use. In recent times the use of sulphur dioxide has diminished considerably, as it has been recognized that it is neither so sure and strong in action nor so convenient as certain other agents, such as formalin. Probably in future it will be less used than in the past. Formaldehyde vapour is a far more powerful disinfectant than sulphur dioxide, and has the further advantage that it does not act so injuriously on the contents of rooms as sulphur dioxide. Both in the form of liquid washes and as vapour it is now becoming one of the most extensively used disinfectants (see FORMALIN). There are various forms of apparatus by which it is obtained as vapour for disinfecting rooms and their contents. About an ounce of formaldehyde in the form of paraform will give enough vapour to disinfect 1000 cub. ft., and will do it much more thoroughly than 1½ lb. of sulphur. It can also be used for disinfecting byres and any other places which can be closed up so as to keep the vapour in contact with the articles to be disinfected for a few hours. Formaldehyde is the most effective agent known for disinfecting by fumigation.

Other substances used for disinfecting in the form of vapour are chlorine, carbolic acid, and nitric acid. Each of these has serious disadvantages, which have prevented it coming into general use, while none of these is more effective as a disinfectant than formalin. [J. H.]

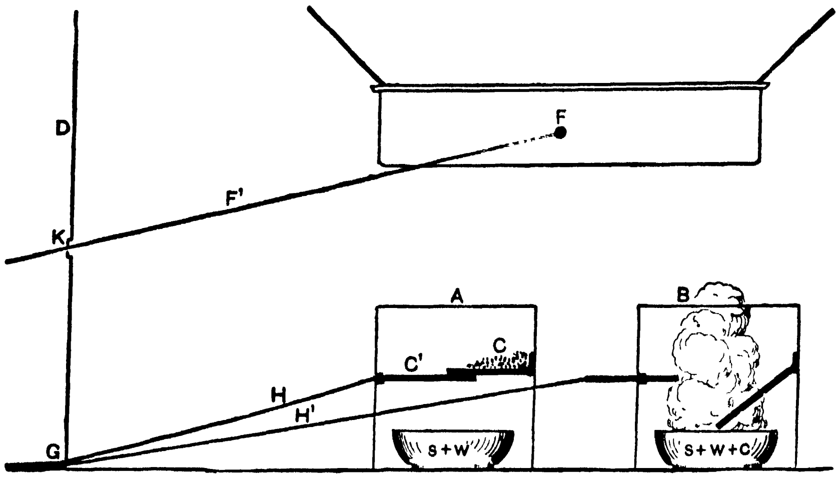
Fumigation for Insect Pests.—The substances used for fumigating plants and seeds, for the destruction of insect life, are hydrocyanic-acid gas, carbon disulphide, tobacco, and pyrethrum. The two latter are mainly used as proprietary articles and need not be further referred to here. Neither seems to have any effect on the eggs of insects, and very little on scale insects, for which fumigation is particularly valuable, but they are excellent and safe fumigants for aphides, white fly, moths, and mosquitoes. Hydrocyanic-acid gas is used as a fumigant in this country under glass to kill Mealy Bug and Scale Insects. It is also used for fumigating nursery stock before planting in orchards and gardens. In America, the Cape, and Australia it is used to fumigate trees in the open when attacked by scale insects, the trees being covered with air-tight tents. This gas is generated by mixing potassium or sodium cyanide, sulphuric acid, and water. The gas is fatal to human and most animal life, and must in consequence be used with great care, or disastrous results may happen to those employed in generating it. The fumigation should only be left in charge of competent hands. One must also bear in mind the poisonous nature of the substances used. The proportions vary according to the kinds of plants to be treated and the state of the plants.

For fumigating dormant fruit trees before planting, the quantities are as follows: 1 oz. of sodium cyanide, 1 oz. of sulphuric acid, 4 oz. of water to every 200 cu. ft. of space. It is even used in the same proportions per 100 cu. ft. of space, but now and then some harm is done to the trees. The sulphuric acid and water are mixed slowly together and then the cyanide is dropped into the liquid. The gas rapidly generates; in consequence one has to proceed with great care, so as not to inhale the fumes, even for a few seconds. This may easily be avoided by purchasing proper fumigating machines, by means of which the cyanide can be dropped into the sulphuric acid and water from outside the fumigating chamber or glasshouse that is being treated.

For destroying Mealy Bug under glass on dormant vines, the same proportions may be used as on dormant fruit trees. For vines in leaf, not more than ⅜ oz. of potassium cyanide or ¼ oz. of sodium cyanide should be used to every 100 cu. ft. of space; to every ounce of cyanide use 1 oz. of sulphuric acid and 4 oz. of water as before. This strength, however, is not sufficient to kill the eggs, so that two or even more fumi-

gations are necessary. This fumigation is best carried out at a temperature of about 50° F., never above 60° F. It should be done on a dull day or towards evening. The trees or plants treated should be as dry as possible. An excess of moisture on plants may lead to fatal results. Unless all these factors are paid attention to, some damage may be done by the gas.

In treating nursery stock at the maximum strength, such as apples and pears, to kill the Woolly Aphis, Mussel Scale, &c., it will sometimes be noticed that the tips of the shoots of certain varieties are burnt. This does not matter at all, and no other damage is done to the trees, whilst the insects in all stages are killed. Stock should be left in the fumes for at least forty-five minutes, and best for an hour. The fumigating chamber should be made so that the fumes may escape from above, and the same applies to glasshouses. This may easily be arranged by a system of pulleys opening the top lights, and half an hour later the doors may be thrown open. No one should be allowed to approach the structures for some time after the houses, &c., have been ventilated. If cyanide of potassium is used, it is very important that it be the 'lump' cyanide, which is practically pure. The 'stick' cyanide contains only 40 per cent of pure cyanide. The cyanide in all cases should be broken into small pieces not larger than a hazel nut, as large lumps become coated with acid sulphate, which protects it from further action of the acid, and in consequence the fumigation is unsuccessful. In large houses it is



Method of Fumigating with Hydrocyanic-acid Gas

D, Door of house; K, keyhole; G, space below door; F, fan suspended from roof, F[1], string through K to move fan; A, fumigating machine set for firing; C, tray with cyanide; C[1], movable support attached to string H passing under door; S + W, bowl containing sulphuric and water; B, the same fired by pulling string H[1] — bowl then containing all three ingredients and gas generating.

necessary to use a separate fumigating apparatus for every 10,000 cu. ft. to be treated. The fumes should be spread by fans fixed above them. In most of the colonies all introduced fruit stock and many ornamental plants, and even fruit, are treated by this process before being allowed to proceed to its destination if insects are present: a wise precaution to prevent the introduction of foreign pests.

The sodium cyanide seems to be the best to use, as it dissolves more readily than potassium cyanide, and weight for weight liberates 30 per cent more gas.

A certain amount of fumigation is done with disulphide of carbon, but for plants it is not as successful as the former. It is largely used in fumigating grain to kill weevils, &c., as well as for a ground insecticide. Where grain, seed, &c., is fumigated, 1 lb. of the disulphide is used to every 100 bus. of grain or every 1000 cu. ft. of space. This substance, which is very volatile, should be placed in a flat saucer above the substance to be fumigated, as the gas is heavier than air and descends. It must also be used with care, as it is highly inflammable and the fumes are poisonous. It must not be used near any light or near live electric wires. As a plant fumigant it does not compare favourably with the former gas, but it is useful for the destruction of ground pests, for certain wood borers (e.g. *Goat Moth*), and for insect-infested seed and grain. The treated seed should be left in the fumes for at least twenty-four hours. Tobacco and pyrethrum are used by burning them in closed houses or chambers. [F. V. T.]

Fumitory (*Fumaria officinalis*, Linn.) is a typical representative of the nat. ord. Fumariaceæ. On the cornfield it is a common, bald annual weed, but too diminutive to be troublesome. The characters of the plant vary much, but it is always marked by the weak, straggling stem, by the leaf cut into numerous segments, and by racemes of small purple flowers. The fruit is a minute one-seeded nut.

Herbalists recommend decoction of fumitory for jaundice and skin diseases. [A. N. M'A.]

FUNGI

Fig. 1—MOULDS

1, White Mould (*Mucor Mucedo*), part of a plant showing mycelium and spore-heads (× 40). 2, Spore-case of *Mucor* with enclosed spores (× 260). 3, Resting-spore of *Mucor* formed by fusion of two branches (× 180). 4, Blue-green Mould (*Eurotium*), mycelium with conidial heads (× 30). 5, Conidial head of *Eurotium* (enlarged). 6 and 7, Stages in the formation of ascospores of *Eurotium* and *Penicillium* (highly magnified). 8, Blue Mould (*Penicillium*), mycelium with conidial heads (× 40). 9, Conidial head of *Penicillium* (× 200).

Fig. 2—HYPHÆ OF PARASITIC FUNGI

1, Hypha of a *Peronospora* living between the cells of the host plant and absorbing nutriment by knoblike suckers. 2, External hyphæ of an *Erysiphe*; only the suckers penetrate into the host plant. 3, Internal hyphæ of a *Polyporus*, boring their way from cell to cell of the wood. (All highly magnified.)

FUNGI

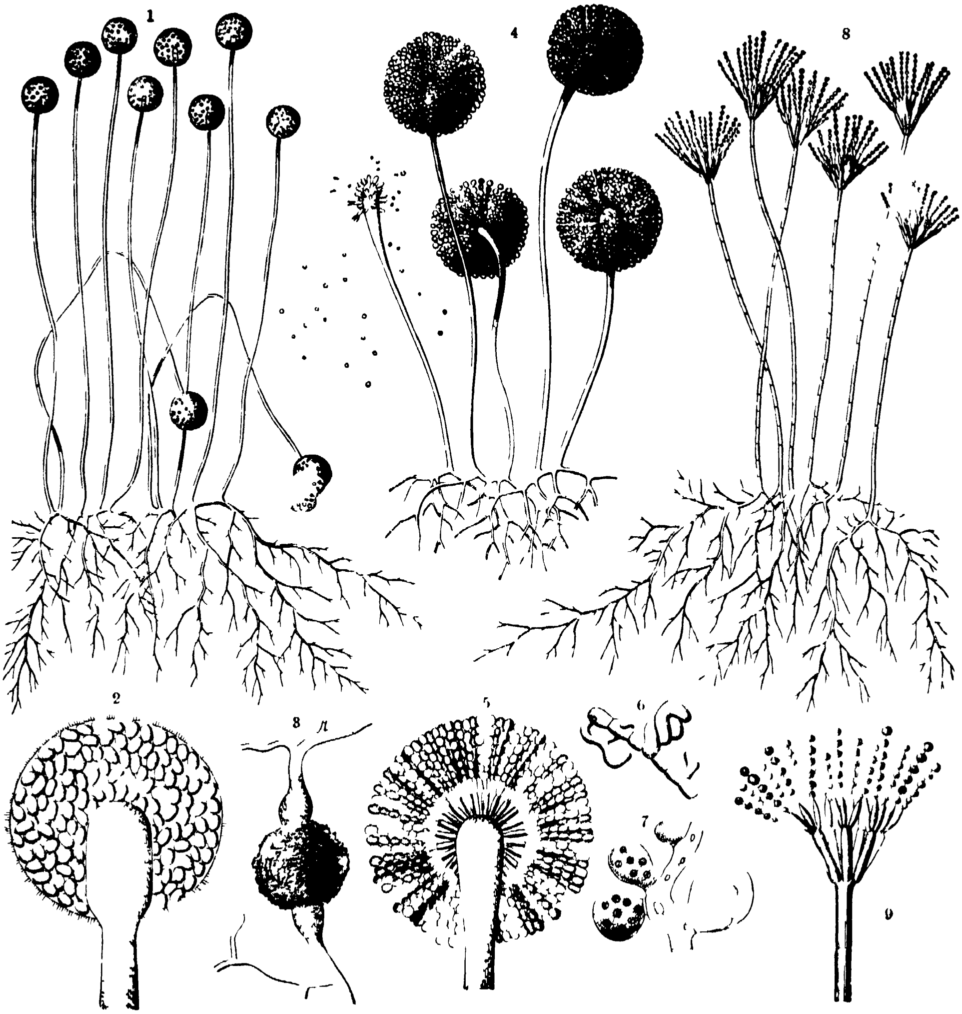


FIG 1—MOULDS

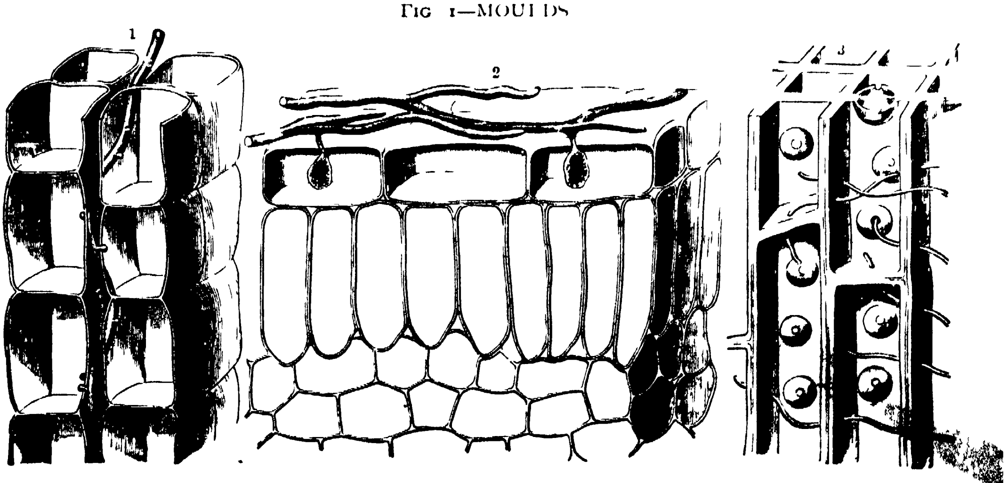


FIG 2—HYPHÆ OF PARASITIC FUNGI

(See description opposite)

Fungi.—The Fungi may be briefly defined as a low group of plants with vegetative organs of simple structure and possessing no green colouring matter. *In none of the fungi do we find green leaves such as almost all flowering plants, ferns, and mosses have. A few of these higher* plants have no green colour (see DODDER, BROOM-RAPE), but in actual practice these are not likely to be confused with fungi. Amongst the many varied organisms included in the lower groups of plants, the presence of the green colouring matter—chlorophyll—as in the Algæ (see art. ALGÆ), and its absence in the fungi and bacteria, is a feature of fundamental importance.

NUTRITION.—Plants absorb water and substances in solution from the soil or other substratum, and from the air they can obtain gases such as oxygen and carbon dioxide. These materials in themselves do not nourish the plant directly, but must be combined into new forms, such as simple proteids and sugars, before they can be assimilated into the living substance of the plant. The power of building up absorbed substances into plant food is not possessed equally by green and non-green plants. This is especially the case with carbon dioxide, the gas given off by all plants and animals during respiration. Green plants placed in light can absorb this carbon dioxide from the atmosphere and give off oxygen, the chief element in 'fresh' air. Non-green plants, however, behave like animals, giving off the carbon dioxide as a waste product which they cannot utilize; for this reason a cellar, or other dark close place with fungi growing in it, becomes deprived of oxygen and filled with carbon dioxide and other gases fatal to animal life. Since the body of a plant contains a high proportion of carbon, this power of the green plant to acquire its supplies direct from the atmosphere gives it a very decided advantage. Light is the chief agent in the process, and only plants which contain green chlorophyll can utilize light as a source of energy. Fungi must obtain their carbonaceous food material from sources where it is to a certain extent ready made. Hence they are found living as saprophytes on dead remains of plants and animals, or preying as parasites on the living. This distinction is of considerable economic importance. If a fungus attack a living plant, it will produce injuries which in the case of cultivated plants may lead to financial loss. Saprophytes, on the other hand, are active scavengers, utilizing dead remains and excreta, thus preventing their accumulation, and even making them available again as sources of food for plants. The line between them is not always a sharp one, for many fungi are known to live on dead remains during part of their existence, and under favourable conditions to become parasites.

GROWTH.—The growth and reproduction of fungi can be followed if careful observations are made on the common forms of mould which grow so frequently in damp places (fig. 1). As a rule, a fungus starts its career from some kind of sporule. The sporule is like a seed in that it gives rise to a new plant, but its simple structure makes it very different from the complex seed. A sporule may consist of one or several cells, but includes nothing comparable to the embryo plant found in seeds. The sporule contains oil or some other food material, some *living protoplasm, and a speck of denser protoplasm—the nucleus; from this simple beginning the mould arises if conditions are suitable.* Germination begins by the sporule absorbing water and swelling, then one or more germ-tubes are given off. Multitudes of germinations die away at this stage, because further growth will only take place when a supply of suitable food is available. If the germ-tube comes into contact with nutriment suited to the requirements of the mould, it elongates and branches, so giving rise to the vegetative body or mycelium of the fungus. This mycelium, when examined by the microscope, is seen to consist of numerous thread-like tubes, known as hyphæ, which contain protoplasm. The young mycelium may frequently be seen on the surface of bread, jam, leather, &c., as a white rounded cushion of aerial hyphæ; other hyphæ dip down and act as roots in fixing the mycelium to its substratum and in absorbing food materials; they also secure food for the plant by giving off a fluid—or enzyme—which has the power of attacking insoluble matters and rendering them soluble. Frequently fungi have their mycelium entirely embedded in the substratum; this is the case with the edible mushroom, which remains invisible until it sends up its spore-bearing organs in the form of the well-known toadstools.

REPRODUCTION.—After a time the vegetative mycelium generally begins to give off sporules intended for dispersal, so that new colonies of mould may be established. The forms of spores produced by fungi are numerous and often perplexing, especially when the same mycelium gives off several distinct kinds. Fungi are very subject to changes in their surroundings, sometimes being amply supplied with water and nutriment, at other times hardly able to obtain enough to live on. These fluctuations and the necessity for abundant reproduction are provided for by the same fungus being able to produce different kinds of sporule adapted to meet every contingency. The White Mould produces at least three distinct forms of sporule, according to conditions:—

(*a*) In an actively growing culture, such as can be obtained in a few days by keeping fresh horse droppings, or some bread, or malt, in a damp covered dish, numerous slender stalks with a white (or in some cases black) head can be observed growing from the mycelium (fig. 1 (1) and (2)). Each head consists of a spore-case containing spores, and when the case bursts, the spores are dispersed so widely that they can be found in almost any room. These spores can only live for a short time, and soon die unless conditions occur favourable to their germination.

(*b*) When the mycelium is not exposed to air but is entirely embedded, as it is inside a cheese, sporules are produced by a process of budding very similar to that of yeast, hence known as 'mucor-yeast'; this form carries on fermentations like true yeast.

(*c*) When the nutriment is almost exhausted, then resting-spores or zygospores are formed

(fig. 1 (3)). This kind of spore is formed after two hyphal filaments have fused and their contents have mingled, hence it is a spore resulting from a sexual process. A zygospore has a thick, wrinkled coat, and can live for a long time in a dormant state, or perhaps be blown about by wind or carried otherwise, till it comes into contact with moisture; then it will give out one or more germ-tubes and so found a new colony, all the more vigorous because of its double parentage.

The Blue Mould (*Penicillium*) and the Blue-green Mould (*Eurotium*) are also common. They exhibit two well-marked forms of sporule, one produced in great numbers and shortlived, the other resulting from the fusion of two tubes and capable of surviving for a long time. The shortlived are known as conidia, and are not formed inside a covering, but arise in chains from peg-like sterigmata on the swollen head of the conidiophore (fig. 1 (4), (5), (8), (9)). The longlived are distinguished as ascospores, and are formed inside a covering —the ascus—which again is enclosed in a thick case, the ascus-fruit (fig 1 (6), (7), and fig. 5).

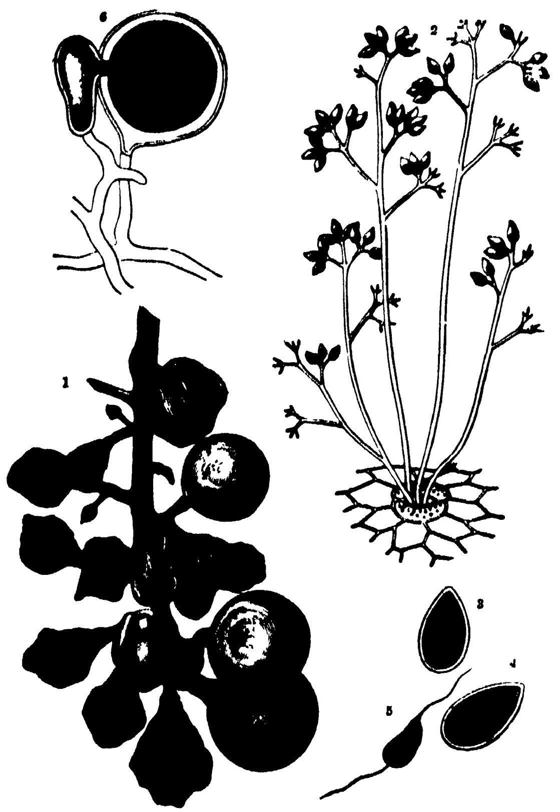


Fig. 3.—Downy Mildew of Grape Vine (*Peronospora viticola*)

1, Grapes shrivelled from attack (nat. size). 2, Branches with the summer spores emerging from a leaf (× 80) 3, 4, 5, Formation of motile spores from summer spores (× 350) 6, Fusion of male tube with egg organ to form a resting-spore (× 350).

Classification of Fungi.—Just as the flower structure has been adopted as a better guide to the classification of flowering plants than the somewhat changeable characters of leaves or stems, so with the fungi the different forms of sporules are used. The natural classification is based on the reproductive organs of the sexual generation. If these are unknown, the other forms of sporule are taken as guides. The botanical name of a fungus also follows the binomial rule used for higher plants; for example, the Ergot fungus belongs to the genus *Claviceps*, and the species *purpurea*; its botanical name is *Claviceps purpurea*. Genera which are closely related are grouped into families, and these again into still larger categories. The following example will illustrate this:—

Botanical, *i.e.* the generic-specific name: *Claviceps purpurea.*

Family: Hypocreæ.

Sub-order: Pyrenomycetes.

Order: Ascomycetes.

Sub-kingdom: Fungi.

The details of grouping fungi will always be the work of the specialist, but an elementary knowledge of parasitic fungi is useful to the grower of plants as a guide in selecting methods of treatment. A short account of the more important groups is given here, sufficient to connect together the parasitic fungi injurious to cultivated plants which are described, and in many cases illustrated, throughout the Cyclopedia.

The True Fungi have generally a mycelium composed of filamentous hyphæ, and this, along with the characters of their sporules, enables them to be differentiated from other low groups of non-green organisms. The Bacteria are most conveniently considered as a separate group (see Bacteria). The Myxomycetes, or slime fungi, are also excluded from the true fungi (see Finger-and-Toe). The following are the more important groups of the true fungi:—

Order *Phycomycetes, or Alga-like Fungi.*—The simplest forms are found in water, others in moist places, and a number live on land or on land-plants. The resemblance of their reproductive organs to those of the green algæ has given rise to the view that these fungi may be algæ which have become saprophytes or parasites, and which have lost their green colour. The group includes the species of *Peronospora*, which give rise to the Downy Mildew disease on many cultivated plants. The mycelium is internal, living amongst the cells of the host plant and obtaining nourishment by special suckers (fig. 2). The summer sporules are formed on branches which emerge from leaves, &c., of the host plant; each may give rise to several motile spores with hair-like appendages which enable them to swim in dew on the leaves, and so carry infection from one part of the host to another (fig. 3 (2), (3), (4), (5)). Resting-spores result from the fusion of a male tube with an egg-shaped female organ (fig. 3 (6)). Other details of the life-history of the Downy Mildews and how to combat their attacks will be found

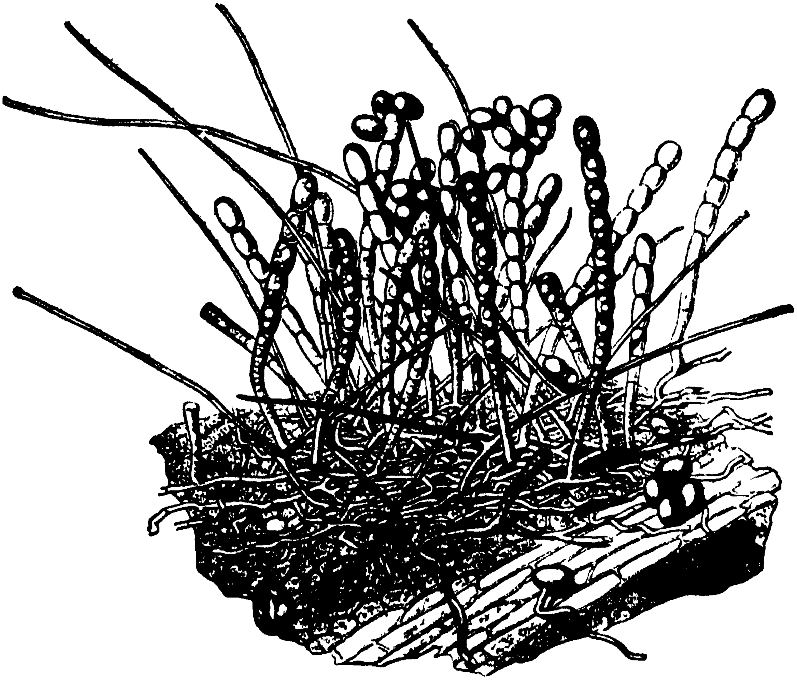


Fig 4.—Powdery Mildew of Peach (*Sphærotheca pannosa*)

Mycelium and conidiophores on surface of leaf Several of the ripe terminal conidia have fallen and are germinating (highly magnified). (From Tubeuf.)

in the various articles on parasitic fungi of crop plants. The common potato disease is the work of *Phytophthora infestans*, a closely allied fungus (see POTATO DISEASE under the heading POTATO—PARASITIC FUNGI). Moist conditions are specially favourable to the growth of Phycomycetes, hence we find several species very destructive amongst seedlings (see DAMPING-OFF). *Cystopus*, another member of the group, gives rise to White Rust of Cruciferæ (see RADISH PARASITIC FUNGI). Fish are also hosts of fungi of this group, as in the case of the salmon disease, due to *Saprolegnia ferox*. Flies, caterpillars, and other insects are also killed off in large numbers by other species. In addition to these parasitic forms there are numerous saprophytes.

Order *Ascomycetes*, a large group of fungi which at some period of their life-history have ascospores developed in a special sac called an ascus (figs. 5 and 6).

Sub-order 1, *Pyrenomycetes.*—The Erysipheæ attack many cultivated plants and give rise to Powdery Mildew, which is distinguished from Downy Mildew (see above) by its external mycelium (fig. 2 (2)), by its summer sporules or conidia produced in chains (fig. 4), and by the ascus-fruits. The latter appear on leaves, &c., as tiny black specks which are easily detached and carried about by wind and animals. When the time comes for germination, the outer case breaks and the ascus-sacs emerge and burst, thus liberating the ascospores (fig. 5). Additional details will be found in arts. on GOOSEBERRY—PARASITIC FUNGI, and ROSE—PARASITIC FUNGI. The Ergot of grasses and cereals (see RYE—PARASITIC FUNGI) is an example of this group with a somewhat complex life-history. Leaf-spots on cultivated plants are frequently caused by As-

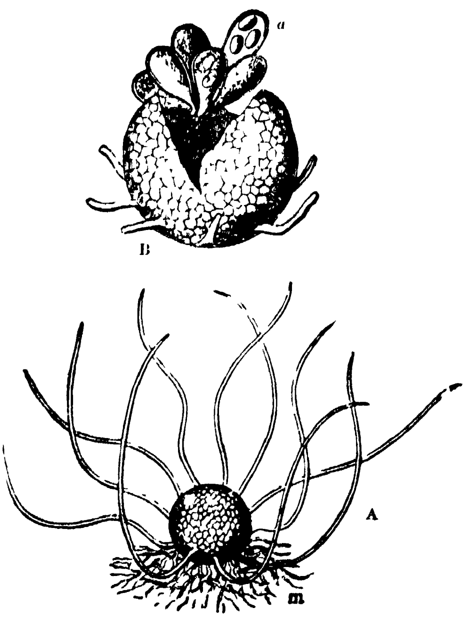


Fig 5

A, Ascus-fruit of Erysiphe communis; *m*, mycelium B, The same (more highly magnified), showing escape of asci (*a*), in which the ascospores can be seen.

comycetes, which live on the leaves and produce summer-spores, while the winter ascus-stage comes to maturity on the fallen leaves. The canker of orchard and other trees (*Nectria*) also belongs to this group (see APPLE—PARASITIC FUNGI).

Sub-order 2, *Discomycetes.*—The ascus-fruits in this group open when mature into cup-shaped or saucer-like

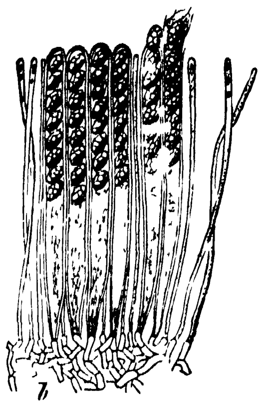


Fig. 6

a, Cuplike ascus fruits of *Peziza aurantia*, an orange-coloured Discomycete. *b*, Small portion from inside of cup showing ascus sacs with 8 ascospores (highly magnified).

disks, lined inside with a compact layer of asci and slender hairs (fig. 6). Many of them are brightly coloured and may measure an inch or more across, hence they are conspicuous fungi. Almost all the species live on dead wood, &c., but a few are parasites, and are referred to in

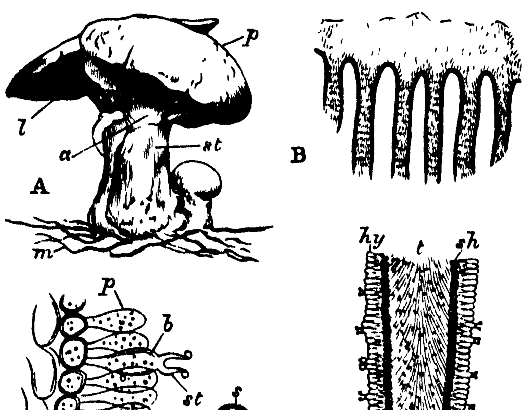


Fig. 7.—The Common Edible Mushroom

A, Group of Mushrooms, two of which are full-grown, and one is still unopened; *m*, mycelium; *p*, pileus; *l*, lamellæ; *a*, the veil; *st*, stipe. B, Section through the cap showing gill-plates. C, Portion of a gill-plate, more highly magnified; *hy*, hymenium; *sh*, sub-hymenial lager; *t*, trama. D, Part of C, still more magnified, showing two basidia (*b*), one bearing basidiospores (*s*); *p*, paraphysis; *st*, sterigmata.

other pages (see LARCH DISEASE, CLOVER SICKNESS, SYCAMORE—PARASITIC FUNGI).

Order, *Hemiascomycetes.*—A number of fungi are placed here because they are regarded as intermediate between the Ascomycetes and the Phycomycetes. The Yeast-fungus (*Saccharomyces*) is a well-known member of the group. The Exoasci are parasites on many plants, and produce asci on the outer surfaces of leaves and fruits, but no ascus-fruits are formed. Amongst the commoner diseases caused by the Exoasci are 'pocket-fruits' on plum, leaf-curl of peach, leaf-spot on birch, poplar, &c., and 'witches' brooms' on birch, cherry, &c.; they are further described in the articles on parasitic fungi of these plants.

Order, *Basidiomycetes.*—The distinguishing feature is that the spores (basidiospores) are borne on basidia, which are generally club-shaped, and have two, four, or six short slender branches, each of which bears one basidiospore (fig. 7). The basidia generally stand closely and form a layer or hymenium, which covers the gills on the lower surface of the Mushroom. The mycelium or spawn lives buried in humus or decaying matter, but some species are parasitic on living timber.

Sub-order 1, *Hymenomycetes.*—This includes the many forms of Mushroom fungi. The Agarics or toadstools are almost all saprophytes, and several species are edible. The Honey Agaric (*Agaricus melleus*) is, however, a parasite very destructive in young tree plantations. The mycelium is at first saprophytic, but it has the power of attacking living roots through wounds, thence it spreads up the tree between the bark and the wood; the spore-bearing toadstools appear at the base of the tree, a connection being kept up between the mycelium which produces them and the hyphæ which absorb nutriment up in the tree by means of black cordlike strands which can be seen under the dead loose bark. The Polypores are another family very injurious to timber trees. The spore-bodies are frequently bracket-like, attached by one edge, the upper side being compact and forming a roof, while the slits and pores on the lower surface are lined by the hymenium (fig. 8). Other details useful to the forester will be found in the arts. on PARASITIC FUNGI OF BEECH, ASH, OAK, and on TIMBER-DESTROYING FUNGI.

Sub-order 2, *Gasteromycetes.*—The most familiar examples are the puffball fungi (*Lycoperdon*, &c.), so common in grass land. The distinguishing feature is that the basidiospores are formed in closed chambers, from which they escape by rupture of the envelope (fig. 9). All the fungi of this group are saprophytes and frequently attain a large size.

Order, *Hemibasidiomycetes.*—This includes two important families of parasites—the Rust fungi, and the Smuts and Bunts. At one time these were ranked as independent orders, but recently have been linked to the Basidiomycetes, because at one period of their life-history they pass through a basidium stage.

1. *Ustilagineæ* (Smut and Bunt Fungi).—If one follows out the life-cycle of *Ustilago* or Smut (see BARLEY—PARASITIC FUNGI), or that of the genus *Tilletia* or Bunt (see WHEAT—PARASITIC FUNGI), it will be found that the dark sooty powder formed in the ears and grains consists of spores, which if placed in a

drop of water will germinate in a few days; they give off short tubes, the basidia, on which

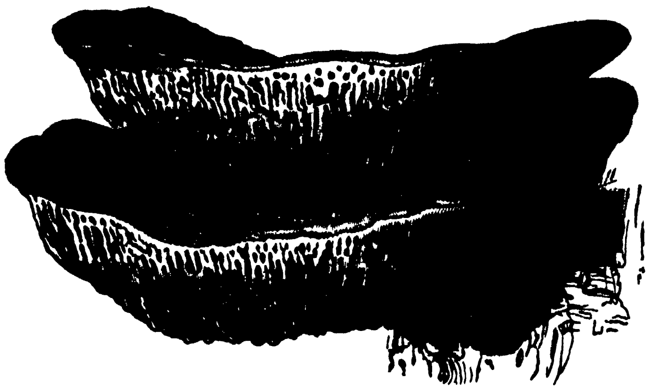


Fig. 8.—Dædalia quercina on Oak

basidiospores are formed, capable of infecting fresh plants of wheat, barley, oat, or some other host plant (fig. 10).

2. *Uredineæ* (Rust Fungi), a widespread group, parasitic on almost every cultivated plant, and very common on wild plants. The life-history is frequently complex, and may involve the formation of five forms of sporules (fig. 11). The life-histories of the more important parasitic rusts are given under each crop-plant, so that it is only necessary here to refer briefly to the kinds of sporules. The *teleutospore* is formed by almost every rust, and it is used as a basis of classification; thus rusts with one-celled teleutospores are placed in the genus *Uromyces*, two-celled into *Puccinia*, and so on. The teleutospore has a thick dark coat, and is thereby adapted to live over winter as a resting-spore. When germination takes place, one or more germ-tubes are formed and bear a few branches, each of which gives off a tiny colourless *sporidium*; the germ-tube is regarded by some to be a basidium bearing basidiospores (fig. 11, B). The infection of a plant is effected by these sporidia. Some rusts (see HOLLYHOCK RUST) only form teleutospores and sporidia, but it is more frequent to find *uredospores* on a rusted plant during early summer, and the teleutospores later in the season. Uredospores differ from teleutospores in their lighter brown, orange, or yellow colour, and their thinner walls (fig. 11), and they do not retain their vitality so long. The most complex life-history is met with when *æcidiospores* and *spermatia* are produced in addition to the three forms already described. *Æcidiospores* are formed inside an æcidium-cup (fig. 11, C); *spermatia* are tiny sporules formed inside much smaller cups, which are generally present on a plant along with the æcidium-cups. Some rusts with an æcidium stage have two distinct forms of mycelium occupying different plants; for example, one rust of grasses and corn crops has its uredo-teleuto-mycelium in these plants, whereas its æcidium-mycelium is on Barberry (see *Rust* under WHEAT — PARASITIC FUNGI, and also fig. 11); other examples of these 'two-host rusts' are described (see JUNIPER, PINE—PARASITIC FUNGI, &c.). On the other hand, all forms of spore may occur on one plant (see ASPARAGUS—PARASITIC FUNGI, RASP—PARASITIC FUNGI, &c.).

Fig. 9.—Geaster multifidus, a Gasteromycete

Two spore capsules after appearing above-ground; at first each was enclosed in a leathery envelope, but later this has ruptured in two layers; the opening in the inner envelope allows basidiospores to escape.

Order, *Deuteromycetes*.—This includes a large number of fungi which do not fall under the

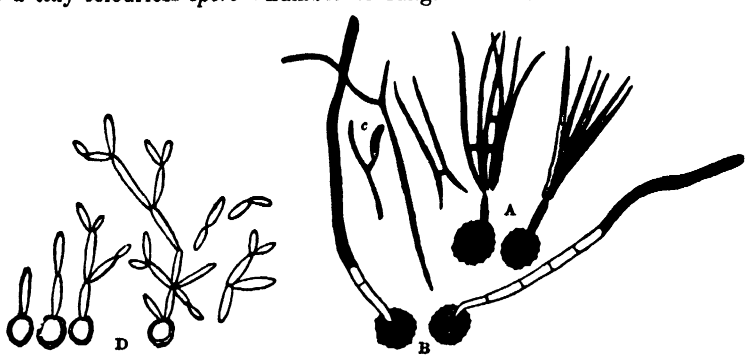


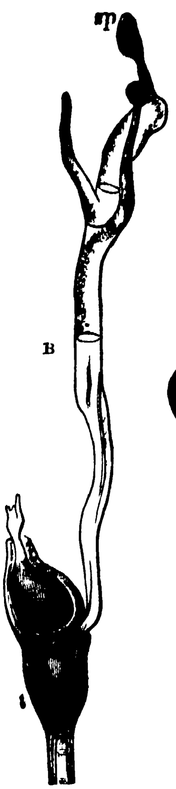
Fig. 10.—Germination of Spores of Bunt and Smut

A, Two spores of Bunt (*Tilletia tritici*) germinated in moist air, each with a short germ-tube bearing a crown of long sporidia (basidiospores), several pairs of these have fused, and produce secondary sporidia (*c*). B, Two spores germinated in water. D, Germinated spores of Smut (*Ustilago*) in plum-gelatine, the oval bodies formed on the two more advanced ones are sporidia. (From Tubeuf)

above groups. They are a very mixed lot, and it is generally believed that they are stages in the life of fungi whose life-histories are not yet fully known. Many parasites are included in

the group, some of them of considerable economic importance, and are referred to in connection with plants described in this Cyclopedia. A few may be mentioned here for reference: Apple and Pear—Leaf-spot, leaf-scald, fruit rot, fruit scab; Barley and Oat—leaf-stripe; Tomato—leaf-rust, black rot, sleeping disease, &c.

This brief account of fungi may be supplemented from the textbooks: *e.g.*, G. Massee, Textbook of Fungi (Duckworth, 1906); J. W. Oliver, Systematic Botany (Blackie); Tubeuf and Smith, Diseases of Plants (Longmans, 1897); De Bary, Fungi (Clarendon Press), &c. [W. G. S.]



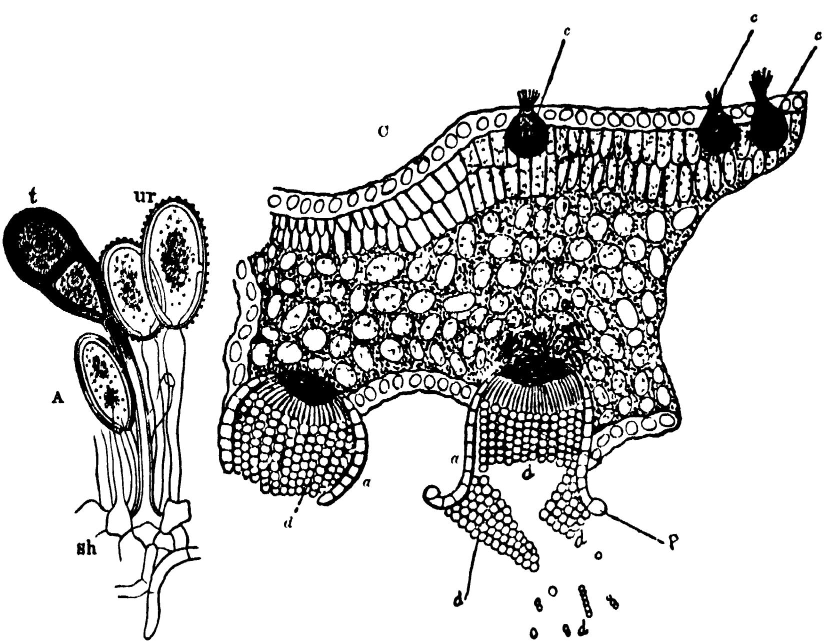


Fig. 11.—Puccinia graminis

A, Portion of a rust-patch with uredospores (*ur*) and a teleutospore (*t*). B, Teleutospore germinating, with a germ tube (basidium) bearing sporidia (*sp*). C, Section of a leaf of Barberry: æcidium cups (*a*) on the lower surface, spermatia-cups (*c*) on the upper surface, *d*, æcidiospores, *p*, wall of æcidium cup which earlier formed a closed chamber. (All highly magnified.)

Fungicides.—A fungicide is literally a fungus killer, but the term also includes substances or processes which check fungus growth. Preservatives used in manufacturing processes are more or less fungicidal or bactericidal. The chief use of fungicides is for the suppression of fungi parasitic on plants or animals. The object aimed at is to utilize the fungicide so that it will kill fungi without doing much injury to the affected crop plants, animals, or man. A fungicide judiciously employed becomes a useful weapon after other preventive and remedial treatment has failed. Suggestions on the best fungicides and their use are given in the articles on parasitic fungi or fungus diseases of the various plants dealt with in this work, and these should be consulted. It is also necessary to know the life-history of the attacking fungi, and to select the stage most suitable for treatment. The stage of growth of the host plant is also important: thus the strongest fungicides can be used for winter treatment of trees and shrubs without leaves, or for seed treatment; weaker fungicides are used for fully developed foliage and for some kinds of fruit; weaker still for young leaves, flowers, and soft fruits. When a fungicide is too strong, this is indicated by the curling or browning of the leaf margin, or the appearance of brown spots or holes in the leaves. Plants vary so much in their resistance that it is impossible to prescribe for every contingency; and success depends much on the care and skill of the operator.

The literature of fungicides is extensive, and scattered through many textbooks and periodicals; only a few of the more useful recipes are given here.[1]

PREPARATION.—PRECAUTIONS.—All fungicides should be treated as poisons, although some are only slightly so. Bottles, &c., should be labelled and kept locked up. The operator should not allow materials to touch hands or face, and should wear overalls and gloves. Iron vessels are frequently acted on by chemicals, hence wooden or earthenware vessels are better. Seeds

[1] *Literature*—Spraying of Plants, by E. G. Lodeman (Macmillan, London, 1896), is the most complete account. Fungicides and Insecticides, and Insects and Fungi, by G. F. Strawson (Spottiswoode, London), are useful for recipes. Journal of Board of Agriculture, also leaflets and diagrams, deal with more important diseases and treatment. Publications of agricultural colleges in Britain, U.S. America, and Europe; also agricultural and horticultural journals.

or plants after treatment should be kept away from domestic animals for some time. Fruits, &c., to be used as food should not be treated when near maturity.

The materials used, *e.g.* copper sulphate, &c., should be purchased from reliable dealers, who will supply pure and of the strength required; cheap qualities frequently contain injurious substances.

Fungicides are applied in three ways: spray fluids, dry powders, or in the form of vapour.

SPRAY FLUIDS.—Useful for almost all parasitic fungi.

1. *Copper Sulphate* (bluestone, blue vitriol, blue copperas). — The purest is 98 per cent strength; the cheaper kinds contain iron sulphate, which is likely to damage foliage. It is used (1 lb. in 10 gal. water) for spraying trees in winter; also as a seed steep (see seed treatment below), and for spraying charlock (see SPRAYING).

2. *Bordeaux Mixture.* — The most useful of the copper spray fluids.

Materials:	Copper sulphate (98 per cent) ...	1 lb.
	Quicklime (fresh burnt)	1 lb.
	Water	10 gal.

Directions (Strawson's).—Dissolve copper in half the water in large wood vessel; slake lime to powder, the finer the better, and add rest of water; pour lime mixture into copper solution and stir well. On settling, the clear fluid should not be tinged with blue; take some in a white cup and add a few drops of potassium ferrocyanide (1 oz. in 10 oz. water); if a brown colour appears, add more lime. When spraying, the lime must be kept in suspension by frequent stirring. The strength of the mixture is varied to suit different plants by increasing or reducing the amount of copper according to the following table; the lime must always be present in excess, and is regulated by the ferrocyanide test:—

Weak Bordeaux	(½	lb. copper sulphate in 10 gal.)
Medium ,,	(1	,, ,, ,,)
Strong ,,	(1½–2	,, ,, ,,)

Bordeaux mixture may be purchased in a powdered form, and is ready for use when mixed with water; this is a convenient form when small quantities are required.

3. *Copper Sulphate and Washing Soda* (*Burgundy Mixture*).

Materials:	Copper sulphate (98 per cent) ...	2 lb.
	Washing soda (pure)	2½ ,,
	Water	10 gal.

Dissolve copper in 9 gal. of water in a wooden vessel, and the washing soda in 1 gal. of water; pour soda solution into copper, stirring continuously. The mixture is tested with blue litmus paper; if this turns red, more soda solution is added, with stirring, till the paper remains blue. This fluid has been found superior to Bordeaux mixture for spraying potatoes (see POTATO DISEASE under the heading POTATO — PARASITIC FUNGI). It is more easily prepared, adheres better to plants, and has no grit to choke the spraying machines.

4. *Cupram, or Ammoniacal Copper Spray Fluid.*

Materials:	Copper carbonate	1 oz.
	Ammonia (strongest solution) ...	½ pt.
	Water	10 gal.

Dissolve copper in some water, and add ammonia carefully till a deep-blue fluid with no suspended matter; excess of ammonia to be avoided. Add water to make 10 gal. This fluid leaves hardly any trace on foliage.

5. *Potassium Sulphide* (liver of sulphur or sulphuret of potassium).—The sulphide is kept in well-stoppered bottles and added to water as required, 5 oz. in 10 gal. water; some plants can stand 10 oz., others only 2 oz. strength. The spray fluid is yellowish-green, and is useful for garden and greenhouse. A little plaster of Paris may be added to show where spray has fallen.

6. *Iron Sulphate* (ferrous sulphate, green vitriol, &c.)—Used to wash trees in winter, 10 to 40 lb. in 10 gal. water.

7. *Lime, Sulphur, and Salt Spray Fluid for winter wash.*

Materials:	Quicklime	7 lb.
(Strawson)	Flowers of sulphur	3½ lb.
	Common salt	3 lb.
	Water	10 gal.

(*a*) Boil half the lime with all the sulphur in 3 gal. water for an hour; (*b*) slake other half lime, mix with 3 gal. water, adding the salt. Pour (*b*) into (*a*) and add rest of water.

8. *Combined Spray Fluids for Fungi and Insects* (see Jour. Board of Agriculture, xi, 1905, p. 645).

SPRAYING MACHINES.—The equipment varies from a hand syringe to a horse-drawn pump and sprayer. Makers' catalogues should be consulted before purchasing; see also Jour. Board of Agriculture, April, 1905. Important conditions are: (1) Portability; (2) ability to produce fine evenly distributed spray; (3) nozzles capable of passing suspended lime, &c., and of distributing both above and below leaves; (4) the mixing gear for stirring up; (5) non-choking of any part when used with Bordeaux mixture; (6) must not corrode. See also SPRAYING.

Seed Treatment.—Employed for smut, bunt, or other fungus spores adhering to seed. The methods employed are described under BARLEY—PARASITIC FUNGI.

DRY FUNGICIDES.—1. *Sulphur* (flowers of sulphur, or sublimed sulphur).—Dusted or applied by bellows to foliage for Powdery Mildew (see FUNGI — 'Erysipheæ', and ROSE — PARASITIC FUNGI).

2. *Lime* in a fine powder, sometimes employed as a fungicide, but is more suitable for insects.

3. *Iron Sulphate* (½ oz. per sq. yard or ½ cwt. per acre) mixed with ashes is recommended as a fungicide for application to soil, not to plants.

GAS PROCESSES.—1. *Sulphur.*—Recommended by gardeners for fumigating greenhouses for powdery mildew. See GRAPE VINE—PARASITIC FUNGI.

2. *Carbon Disulphide* or preparations containing it are employed for soil treatment against fungi and insects. [W. G. S.]

Fungus Gnats. See MYCETOPHILIDÆ.

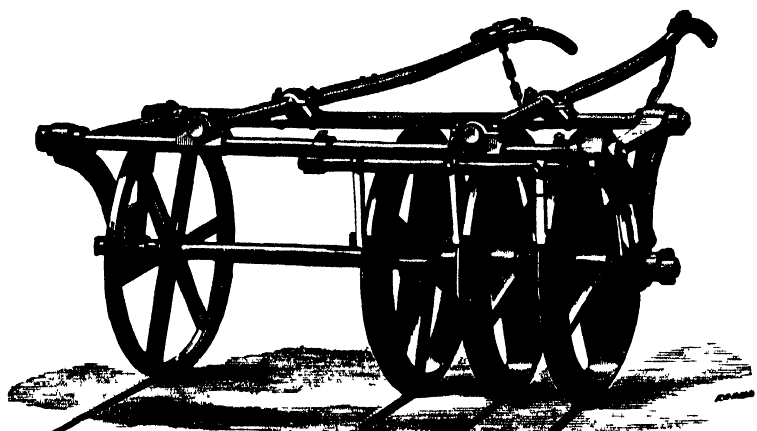
Furlong, one-eighth of a mile, or 220 yd., equivalent to the side of a square of 10 ac.; *originally regarded as the length of a furrow in a field of this size.*

Fur Moth, a species of moth belonging to the Tineidæ or clothes moths, which attack furs and do much harm in fur stores. See TINEA.

Furrier's Refuse. See NITROGENOUS ORGANIC MANURES.

Furrow.—The word furrow has several distinct meanings in farming practice. It usually means the interval or depression between two adjacent ridges, but it may also refer to the trench made by the plough in turning over furrow slices in the operation of ploughing. Shallow surface drains are sometimes called 'furrow' drains. See PLOUGHING.

Furrow Presser.—Furrow pressers are chiefly used on light land, especially on light chalk soils, where it is difficult to get a firm seedbed without them. On ordinary soils they are chiefly used for compressing the land for wheat, which especially requires a firm seedbed; but on light chalk soils it is a common practice to use them for consolidating land to be sown with oats and barley. They are specially valuable after grass and clover leys, as they form a firm seed track at an even depth, and prevent the seed from falling too deeply, as often occurs when the furrows are not well packed. The furrow press is made with two or three, and sometimes four, heavy ring sections, strung on a spindle, the land side of the frame having a balancing light travelling wheel. The sections can be adjusted to the width of the furrows. The furrow press follows the ploughs, the horses in the shafts walking up the open furrow last turned, thus pressing as many furrows as there are rings; consequently the number of ploughs a presser will work to is decided by the number of rings. [W. J. M.]



Furrow Presser

Furrow Slice, the slice of earth turned over by the plough. The requisites of good furrow slices are that they should all be of a uniform breadth and depth, that they should be parallel and straight. The shape of the furrow slice varies according to the make of the plough and the method of ploughing. See PLOUGHING.

Furze—also known as the Whin or Gorse—a spiny evergreen leguminous shrub with bright-yellow flowers. See WHIN.

G

Gabbro, a name given by Von Buch to diorites containing pyroxene in place of amphibole or mica. The rock now regarded as the typical gabbro consists of a lime-soda or lime felspar and augite (often diallage), with magnetite or titanic iron-ore. Gabbros, like diorites, form rugged country, and yield ferruginous and fairly calcareous soils on weathering. *Olivine-Gabbro* contains olivine in addition. This rock forms the dark mountainous masses, cleft by irregular joints, of the Cuillin Hills in Skye, and the similarly irregular mountain of Carlingford in Co. Louth. [G. A. J. C.]

Gable, the triangular end of a building from the level of the eaves to the ridge of the roof. Gables may simply be a continuation of the end wall, or they may slope inwards at an angle from the level of the wall heads, as in the 'pavilion' or 'hipped' roof.

Gad-flies, a group of the blood-sucking diptera belonging to the family Tabanidæ. See TABANUS.

Gaiting, or **Gaitning,** a method of facilitating the drying of sheaves of corn during harvest-time. The sheaves are loosely tied near the top, given a swirl so as to spread out the bottom, and then set on the ground singly

Gale, a shrubby plant found in bogs and

moorlands which emits a strong and pleasing fragrance. See BOG MYRTLE.

Galeopsis, a weed belonging to the nat. ord. Labiatæ, commonly found among oats. See HEMP NETTLE.

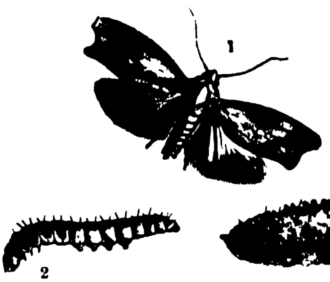
Galerucella tenella (the Strawberry-leaf Beetle).—A small beetle, only ⅙ in. long; it is oblong-ovate, and convex in shape, dull-yellow to brownish; head yellow, with a broad black stripe on the top; thorax with yellowish tint, a dark line along central furrow, and on each side a small round depression; wingcases granulated and shiny, varied in colour, sometimes yellowish, at others brown, with margin and suture yellow, and often a brown spot on each; abdomen black beneath; legs pale; antennæ long, black at the tip.

Normally it feeds on Willow, Alder, Spiræa, and Potentilla (Silver Weed). The beetles and larvæ perforate the leaves in irregular holes right through the leaf, and also they eat off the outer skin. The beetles lay their eggs on the under side of the leaves. Two or more broods occur. The larvæ are elongate and wrinkled, with lateral tubercles, and with a tubelike anal process. They are gregarious, and hence very harmful where they occur. The pupal stage is passed in the ground. *Treatment* consists of spraying with lead arsenate to kill the second brood after the fruit is picked, and removal of all weeds and rubbish between the rows in late autumn. [F. V. T.]

Galium, a genus of weeds belonging to the nat. ord. Rubiaceæ. See BEDSTRAW.

Gall, Saddle.—Galls resulting from the pressure of saddles or harness should receive prompt attention, as they are likely to throw the animal out of work, cause much pain, and induce lasting fidgetiness when mounted. Neglected saddle galls lead to fistulous withers (which see). Flinching over the region injured, when pressed by the hand, swelling, and perhaps abrasion of the skin will be noticed, and time will generally be saved by poulticing, and rest from labour. If the animal cannot be spared, the offending saddle should be cut out or the collar or harness pad raised by other means, so that no bearing shall take place on the gall. A cooling aperient may be given with advantage to horses full of corn or disposed to form matter on slight provocation. In the case of failing to disperse galls by fomentation and poulticing, it may be necessary to ripen them and lay open with the lancet, which should be done with a bold incision if done at all, or matter again accumulates. A paste of fuller's earth and glycerine assists the healing process. The skin should be allowed to harden before any pressure is again permitted. [H. L.]

Galleria cereana (the Bee Moth).—The caterpillars of this moth at one time were very annoying to beekeepers, but since more scientific apiculture has been in vogue, little harm is done by them. The moth (see fig.) is about ¾ in. long, and with wing expanse of from 1 to 1¼ in.; front pair deep-reddish-grey, yellowish-brown towards the inner margin, with two faint brown oblique bands; sometimes there is a faint greenish tinge, and they are notched at the tips in the male; hind wings ashy-grey, with pale fringes edged with white; head, thorax, abdomen, and antennæ dull-yellowish-brown. The female is larger and darker than the male, and the head and thorax reddish-brown; the snout is also longer, and the wings nearly rectangular. The moth is double-brooded, the first brood appearing in April, the second in August and September. The female lays her eggs in the cracks and crevices of the beehives at dusk as small white globular bodies which hatch in about seven days. The larva (see fig.) when full-grown is about 1 in. long, cylindrical and yellowish-white in colour, with brown head and second segment, typical lepidopterous legs; each segment has faint yellowish-brown spots, all of which emit a single hair. The young larvæ seek the lower layers of the comb. After feeding on wax they spin themselves tubes of whitish silk, where they pass the day, feeding at night. Three



Galleria cereana (the Bee Moth)

1, Moth. 2, Larva. 3, Cocoon

to four weeks is the period of life, and all this time the silken tubes are being enlarged. When full-fed they spin a cocoon of silk (see fig.), in which they pupate. The pupa hatches in two or three weeks in summer, but in the late brood they remain as such all the winter. The result is that they not only destroy the comb, but the bees get caught in the webs, and the pressure caused by the tunnels kills the young brood. Weak 'stocks' are mostly invaded, and queenless colonies nearly always so. *Prevention* and remedies are obviously hand-picking and the keeping up of strong healthy stock. [F. V. T.]

Galley Worms, a popular name for centipedes, such as the common *Lithobius forficatus*, which is often seen under stones and bark—a reddish-brown animal about 1 in. long, with fifteen pairs of yellowish legs. All are carnivorous and poisonous, and do much more good than harm. They must not be confused with the vegetarian millipedes, some of which are known as 'false wireworms'. [J. A. T.]

Gall Mites, a family of mites or acari which produce galls or deformities on plants. See ERIOPHYIDÆ.

Gallon.—By 5 Geo. IV, c. 74, the imperial gallon is declared to be the standard measure of capacity, and to contain 10 lb. avoirdupois weight, or 277·274 cu. in., of distilled water of 62° F., the barometer standing at 30 inches. The old English wine gallon measured 231 cu. in.; the old ale gallon 282 cu. in.

Galloway Cattle. — Galloway Cattle are an original and distinct breed, which at one time belonged exclusively to that portion of country in the south and west of Scotland *which went by the name of the ancient province of Galloway, and which at that time embraced the greater portion of what may be* termed the south-western lowlands of Scotland. The term '*Galloway*' which gave the name to this breed of cattle has, however, been confined entirely for a very long period to the two counties of Kirkcudbright and Wigtown, known respectively as the Stewartry and the Shire. The origin and history of the Galloway breed of cattle is wrapt in considerable obscurity. From what can be gathered from written tradition, it seems reasonable to infer that the race from which the present-day 'perfect Galloway' has evolved was the native 'middle horns', which in the early history of the country was the prevailing breed in the south of Scotland, and which also no doubt gave us the 'polled Angus', as well as the West Highland Cattle, the horns being developed in the latter breed, whereas in the two first-mentioned the horns were almost entirely bred out, until they were known as 'polled', 'dodded', or 'humble cattle'.

Whatever may have been the source from which the Galloway breed sprung, it is obvious that the West Highlanders have come from the same remote ancestors; for when we take into consideration the fact that at one time the Galloways were mostly horned, it is easy to see how by judicious selection and careful breeding the two different types have been produced under different treatment and different circumstances. We can also understand how even the colour has been fixed in the Galloway and variegated in the Highlander when we consider that at one time there were 'sporting' colours among the Galloways, such as brindled, dun, red.

So far as can be gathered from history, Galloways were the prevailing breed of cattle in the counties of Ayrshire, Renfrew, Lanark, Kirkcudbright, Wigtown, Dumfries, and the border counties in the north of England from a very early date; and it would appear that those of south Ayrshire as far back as 1573 had earned a notoriety for their general excellence, as the foreign author and geographer Ortelius specially mentions the cattle of Carrick as 'oxen of large size, whose flesh is tender and sweet and juicy'. Confirming this theory, a modern writer, Youatt, alludes to the number and excellence of the black cattle of south Ayrshire. 'In Carrick', he writes, 'many black cattle are grazed and made ready for the English markets. They are mostly a peculiar breed, the history of which cannot be perfectly ascertained. In the beautiful valley of the Stinchar round Colmonell, there are usually at least three thousand black cattle; the breeding of them is a great object in this part of the country, and their value has rapidly increased.' In the year 1682 the minister of Kirkinner—the Rev. Andrew Symson—while describing the agriculture of the period, refers to the black cattle at Baldoon, the then proprietor (Sir David Dunbar) grazing a thousand head in a large park, and, as was the practice at that time, selling them in the autumn at four-year-old to drovers at home, or sending them to English fairs and getting from £5 to £6 apiece if very large. It was this South trade, which, *continued well on into the last century, that brought about the establishment of the Galloway as a pure 'polled' breed.* The English feeders showed such an objection to the 'horned' animals and such a preference for the 'polled', that breeders were compelled to turn their attention to this important matter, with the result that ere long, by judicious selection and careful breeding, the 'horned' breed decreased until at length it was quite superseded by the 'polled'.

About the year 1786 there arose a zealous admirer and improver of the Galloway breed in the person of the Earl of Selkirk, who, together with his son—Lord Daer—exercised a powerful influence in improving the native breed of cattle. This good work was subsequently carried on by such influential men as the Maxwells of Munches, the Maitlands of Tarff, the Murrays of Cally, the M'Cullochs of Ardwall, the Earls of Galloway, the Maxwells of Monreith, the Hathorns of Castlewigg, as well as by the leading proprietors and farmers in Dumfriesshire and Cumberland.

In the early part of last century the best Galloways were to be found along the Solway seaboard of their native land, particularly in the Borgue and Kirkcudbright districts of the Stewartry, and the Portwilliam and Whithorn districts of Wigtownshire, the exceptional good quality of the land having a natural tendency to the best development of the cattle it raised.

In the year 1821 the Highland Society prize for the best Galloway ox was easily won by a fine specimen of the breed reared by Mr. Mure of the Grange Farm, close to Kirkcudbright. Mr. Mure was also the breeder of the beautiful Galloway heifer 'Queen of Scots', which caused a sensation at the Smithfield Show, and whose portrait was engraved by the sanction of the Smithfield Club. The dressed carcass of this animal weighed 190 st. London weight, or 108 st. 10 lb. imperial weight. The following were her proportions: Height of shoulder, 5 ft. 2 in.; length from nose to rump, 10 ft. 4 in.; width across hip, 2 ft. 6 in.; across middle of back, 3 ft.; across shoulder, 2 ft. 4 in.; girth of leg below knee, 8 in.; distance of breast from the ground, 1 ft. 3½ in.; width between fore legs, 1 ft. 5 in. Such weight and proportions are seldom heard of nowadays among heifers in any breed of cattle, and certainly never among Galloways.

By the middle of last century (1850) very many fine herds of pure polled Galloways were to be found in the south of Scotland, principally along the Solway shore — from Aireyolland, Portwilliam, to Rigfoot, Cumberland — including among many others such prominent farms as Kidsdale, Glasserton, Galloway House, Castlewigg, Cally, Borness, Southpark, Langbarns, Cannee, The Grange (Kirkcudbright), Dunrod, Coorahill, Balig, Mullock, Ducanhill, Almorness, Caigton, Whitecairn, Meikle Culloch, Culmain, Drumlanrig, Annanbank, Newbie, Netherby, Mossband, &c.

Photo C. Reid

GALLOWAY BULL—"HENRY OF TARBREOCH"

WINNER OF FIRST PRIZE AT THE H. & A. S. SHOWS 188[illegible] AND 18[illegible]0

Photo C. Reid.

GALLOWAY COW—"NANCY LEE II OF CASTLEMILK"

WINNER OF PRINCE OF WALES GOLD MEDAL FOR BEST GALLOWAY, H. & A. S. SHOW, 1899

Formation of Herd Book.—Out of these famous herds at a later date the Galloway Herd Book had its origin. The first registrations of Galloway Cattle were put in print by the promoters of the Polled Angus Herd Book, then under the ownership and management of Mr. Ramsay, Banff. This was felt to be unsatisfactory for the Galloway breeders, and at a meeting held in Castle Douglas in 1877 it was resolved, under the convenership of Mr. Maxwell of Munches, to form a 'Galloway Cattle Society' and a 'Galloway Herd Book', and the Galloway section then incorporated in the Polled Angus Herd Book was bought up from its northern owners for £75. A fund of £160 was also raised from ninety-four subscribers, and the Galloway Cattle Society was floated on the 20th June, 1877, with the Duke of Buccleuch as president, the Earl of Galloway as vice-president, and Mr. Maxwell of Munches chairman of the council. The Galloway entries in the Polled Herd Book, totaling 975, were carefully re-edited, and out of this material the first Galloway Herd Book was published, containing nearly 500 entries, representing about 150 males and 350 females; which was followed by the second volume, containing 619 entries — 433 females and 186 males.

A volume of pedigrees has been published in each succeeding year since its inception, and the work of the society still goes on (1908), under the presidentship of Mr. J. M. Aiken Norwood, with the Rev. J. Gillespie, LL.D., Mouswald, as secretary; and in the many volumes that have been published it is computed that considerably over thirty thousand Galloway pedigrees are recorded.

The points, characteristics, and uses of the Galloway are now very clearly defined. The prevailing colour is black, with a brownish mosslike tinge. The colour, however, may be 'dun' or 'red', like the Norfolk polls, which no doubt have a common ancestry with the Galloways; but 'reds' are very much deprecated, and 'duns', though highly valued, are very scarce, existing mainly at three places—Ernespie, Castle Douglas; Barncaughlaw, Newton Stewart, and Miltonise, Stranraer. There is also a 'whitefaced' or 'brocket' variety that used to be common in Wigtownshire, now almost extinct, unless at Creebank, Bargrennan, and Barlay, Gatehouse. There is also a 'white-middled' or 'belted' race of Galloways, very beautiful, but also now very scarce, and only to be seen in small numbers at odd places in the north of England, and in the neighbourhood of Kirkcudbright at Knockbrex and Boreland of Anwoth (see art. Belted Cattle). The conformation of the Galloway is that of a pure beef-producing animal, and for that purpose few breeds can equal it. The body should be blocky, rounded, and symmetrical, with deep and well-sprung ribs; a full breast, with straight back and rump; level-fitting tailhead; long and well-filled hindquarters set on short legs with fine bones. The neck should be moderate in length, slightly raised in a male, and level with the back in a female. The head should be purely polled, with a broad forehead and strong short muzzle. The skin should be mellow to the touch, with a covering of soft wavy hair and a brownish undercoat. It is this covering of hair which, as it were, makes a roof to the back, and gives to the Galloway those hardy characteristics which enable the breed to winter well outside, and thrive in a moist, cold climate. As a milk producer, the Galloway cannot compete with the Ayrshire and other milk breeds; but although deficient in quantity the milk of the Galloway is superior in quality, and occasionally individual cows have been known to be useful for the dairy, and have given a yield of 10 to 12 lb. of butter per week, but this is the exception and not the rule. Very few of the Galloway cows can do more than suckle their calves, which is the invariable practice in successful Galloway calf rearing. As all the best bull calves are kept for bulls, and used when yearlings, they have to be well reared and brought out, so as to meet the demand for strong bulls for crossing with the Shorthorn and Ayrshire. The Shorthorn cross especially makes a first-class feeding animal and a good butcher's beast. For crossing purposes, the Galloways are deservedly held in the highest estimation. The finest blue-greys with the sweetest heads and best backs are generally the result of crossing the Galloway cow with the Shorthorn bull, but the greatest proportion of blue-greys are bred by using the Galloway male and the Shorthorn female. Perhaps one of the greatest uses of the Galloway sire (since Ayrshire milking stock have got such a hold in the country) is for crossing the Ayrshire dairy cow. The bullocks of this Galloway-Ayrshire cross, if well bred and well reared, make very good feeding animals, and the heifers also make good feeders, also good breeders and milkers if crossed with the Shorthorn bull. The most remarkable point in this Galloway-Ayrshire cross is that, if the Galloway bull is pure, 99 per cent of the offspring will resemble the bull very closely, being invariably all black and all polled. In fact, the offspring of a pure-bred Galloway bull and a horned cow of any breed is invariably hornless, so that, for pure prepotency in breeding, no other race of cattle can approach the Galloway. In fact, at certain seasons of the year, among these Ayrshire-Galloway crosses, some individual members of the breed may have so much Galloway type and character about them that they would almost pass for pure Galloways. To achieve this useful object in crossbreeding, the Ayrshire cow should be well haired, dark or blood-red coloured, with a thick, blocky, and wide frame. Thus a combination of dairying with successful cattle rearing can be carried on, and good big-framed cattle can be grown, which feed well and come early to maturity.

About the year 1850 an annual show and sale of Galloways was established at Lockerbie, which was very successful for a time, and which was useful in disseminating fresh blood, by giving breeders an opportunity of selecting young bulls to suit their requirements.

In 1855 Castle Douglas followed in the footsteps of Lockerbie, and a show and sale of young

Galloway bulls was established, when the first prize was won by Mr. James Graham, Meikle Culloch, Dalbeattie, with the famous bull Freebooter (203). Prices at that time and for the next twelve years ran roughly from £30 to £40 for the champion of the show, when in 1877 the price was topped by President of Culmain (1044) making what was then thought the extraordinary figure of £62. Some years later, however, that price was eclipsed by the yearling bull Royal Liberty, of Balig, bred and shown by the Messrs. Shennan, which made £150. The same breeders also got £120 for Viking, which was also the Castle Douglas champion of another year; while on another occasion the first prizewinner, named The Earl of Annandale, bred and owned by Sir Robert Jardine, Castlemilk, made £135.

Under the auspices of the Galloway Cattle Sales Association, shows and sales by auction are held twice a year in Castle Douglas, Kirkcudbrightshire. The spring show and sale, held in February or March, is confined solely to registered bulls, while the autumn one, held in October or November, is confined to females entirely. At the spring show and sale, generally upwards of 150 yearling bulls are exhibited, and the winning of the first prize in this section is considered to be the 'blue ribbon' of the Galloway breed for the season, and there is therefore great rivalry among breeders to win this coveted honour, and produce the best animal of the year. Prices at these sales are now largely guided by supply and demand, prizewinners frequently making from £60 to £80, and others from £20 to £30, while at the heifer sales £40 and £50 is frequently reached for the pick of the market. Some of the best prices for females were made by the late James Cunningham of Tarbreoch, who sold several animals over £100 each, and many close on the three figures. At the Chapelton surplus sale, one female (Lady Stanley) made £95, and another (Mary Graham) £81, while Baroness, also from the Chapelton herd, made £138 at a sale in Chicago. Perhaps the palm for the best breeding Galloway female would lie with the noted cow Maggie of Tarbreoch, and for the best show cow that has been seen with Mr. John Cunningham's never-beaten Dora; while among the best show bulls may be mentioned Crusader, Scottish Standard, Henry of Tarbreoch, M'Dougall IV, Campfollower of Stepford, Excelsior, and Crucifix, while perhaps one of the best breeding bulls that ever lived was the renowned Camp-follower of Chapelton.

The chief markets for ordinary store Galloway cattle, or the polled crosses arising from the use of a Galloway sire, are held during spring and autumn at Carlisle, Castle Douglas, and Newton Stewart, where they are sold by auction, usually in wagonloads; and as there is still, as in days of yore, a strong demand for them to go South, prices are often very high. The 'polls' and blackskins are also considered worth a good deal more per cwt. live weight than any of the coloured horned breeds, and they invariably make more money; good two-year-old store bullocks, in a good trade, frequently making from £14 to £16 each, and good yearling bullocks from £10 to £12 each, and mostly bordering, or sometimes exceeding, 40*s*. per cwt. live weight when off the fodder in the spring.

When Galloway cattle are made into beef, there is a good market for them anywhere, and very often a Galloway or a Galloway cross is champion of many a local cattle show; but it is at the Smithfield Christmas show in London that competition is keenest for the best beef bullock or heifer of the Galloway breed. Some very creditable animals have been shown at Smithfield, and some good prices realized.

In 1872 the first prize in the polled class at Smithfield was won by the Galloway heifer Lalla Rookh, bred at Chapelton, Dalbeattie, while previous to that (1861) Mr. M'Combie won both Birmingham and Smithfield with a Galloway bullock. In 1897 Mr. W. Nimmo's champion Galloway steer weighed over 15 cwt. live weight and sold at £60. In 1899 Messrs. Biggar were champions with a steer weighing 17 cwt. 3 qr., and sold for £55—a feat which the same firm performed for six consecutive years; while in 1906 Messrs. Biggar won the championship in the young class with the steer Challenger, which was sold at the record price of £70 Several champion animals have been shown from Cally, Gatehouse, Claycrop, Wigtown, Auchengashel, Twynholm, Stepford, Dumfries, also from Castlemilk and Drumlanrig, while several English feeders have taken championships with Galloways, including Sir J. Swinburn, Mr. R. W. Hudson, and Mr. Palmer, Wokefield.

The present-day tendency is for Galloway cattle to get into fewer hands, and this has been going on throughout the last quarter of the bygone century, caused chiefly by the Ayrshire dairy cow supplanting the Galloway on many of the best farms in the south of Scotland. In Ayrshire, where the best Galloways were produced in the past century, very few of the hardy blackskins are now to be seen, and what remain are widely scattered over the district, from Dalwhine in the Barr district to Knockiebay, New Luce, where an occasional Galloway champion is still raised.

Perhaps the largest number of good commercial Galloways are yet to be found in Wigtownshire. Special mention may be made of the herd at Glentriplock, Portwilliam (Mr. Peter Anderson's), which contains over twenty breeding cows, that take the palm for size and substance, and for breeding large-framed good commercial cattle. Ten steers from this herd at twenty-two months old made £23 apiece in 1907. The Glentriplock herd is closely followed in size and substance by the herd at Mains of Penninghame (Mr. M'Conchie's), and is exceeded in numbers by that belonging to Mr. John M'Gill, Boreland, Newton Stewart, who has about thirty breeding cows of exceptional commercial merit.

There are also a good many smaller herds in Wigtownshire that occasionally produce an animal that comes to the front, as exemplified in the Smithfield winner of 1906, Challenger, which was bred at Barlauchlan, Newton Stewart, and picked up as a calf by the late Mr. James Biggar.

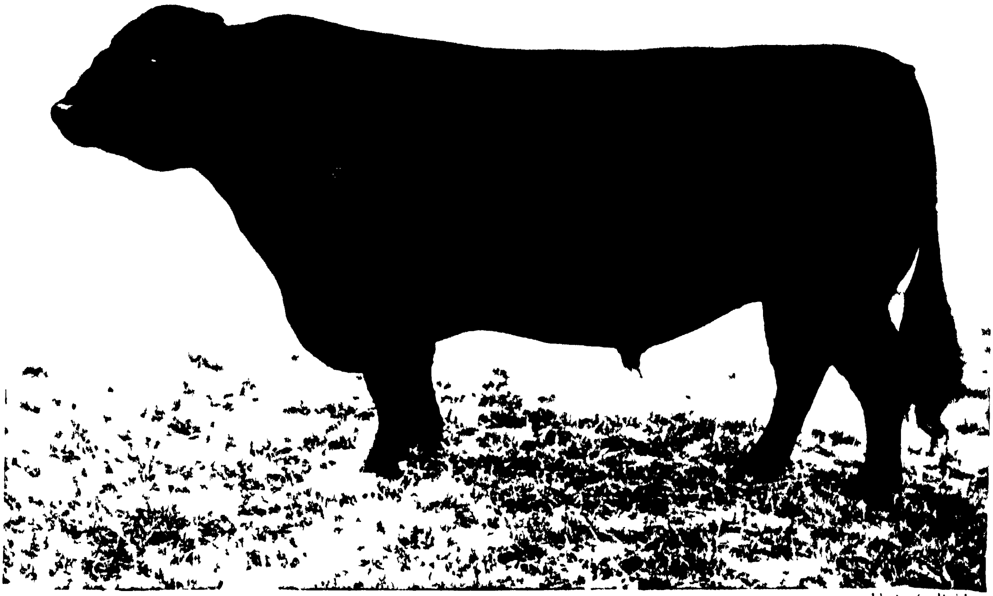


Photo C Reid

GALLOWAY BULL "EXCELSIOR"

WINNER OF FIRST PRIZE H & A S SHOWS 1901 1902 AND 1903

(89)

Photo C Reid

GALLOWAY COW "DORA OF DURHAMHILL"

THREE TIMES WINNER OF THE PRESIDENT'S MEDAL FOR THE BEST GALLOWAY, H & A S SHOWS, 1895 1896 AND 1897

In the Stewartry the Galloways are mostly retained in the hands of those breeders or their families who have for a long time earned distinction in the show ring. In the Borgue and Kirkcudbright districts, where the best Galloways were raised during the last century, there is only one important herd remaining, held by the Messrs. Shennan at Balig. In the colder and later districts in the northern part of the Stewartry, particularly in the Glenkens, several herds of considerable merit are to be found; while in the lower districts Messrs. Cunningham, Tarbreoch; Thomas Biggar & Sons, Chapelton; Mr. Brown, Stepford; Mr. Graham, Auchengashel, and Mr. Montgomerie Neilson of Queenshill, may be mentioned as owning the most noted prizewinning herds of the present time.

The wide county of Dumfries, like its neighbours, has also been largely depleted of Galloways. Prominent among the remaining herds may be mentioned that owned by the Duke of Buccleuch, Sir R. W. B. Jardine, Castlemilk; Messrs. Graham, Marchfield and Chapellogan; while at Mouswald Manse, Ruthwell, there can generally be seen a large number of bulling and in-calf heifers, the property of the Very Rev. J. Gillespie, LL.D.

In the Carlisle, Cumberland, and adjacent border districts a considerable number of purebred Galloways are kept, although, perhaps, mainly for the purpose of crossing with the Shorthorn and producing a large lot of their blue-grey crosses, so much sought after and prized for their ornamental as well as their superior beef-making qualities. The best Galloway herds in these localities are to be seen at the Countess of Carlisle's, Naworth Castle; The Croft, Kirksanton; Allansteads, Pedderhill, Sanden House, &c.; while there is a well-known herd at Belbusk in Yorkshire, also in the south of England at Wokefield Park and at Cholderton.

In Ireland several very good herds are established, and the Galloway bulls are largely used for crossing with the native Irish cattle. The most noted herds in the Green Isle belong to the Earl of Antrim, Glenarm Castle; Mr. Lane, Limavady, and Mr. Caldwell, Ballymena.

During the closing decades of last century, large numbers of Galloways were exported, principally to the United States and Canada. They were also sent to other countries, including Greece, Cyprus, Russia, Patagonia, &c.; but it is principally in North America that the breed has been developed and a record of pedigree kept. The American Galloway Herd Book has an entry of about 30,000 head—almost equal to the entire entries in the herd book of the mother country—which shows the usefulness and value of the hardy Galloway as a rustler in a somewhat rigorous climate; while such names as Swiggart and M'Crae are as well known in America as Cunningham or Biggar among Galloway breeders in the mother country.

[G. G. B. S.]

Galloway Pony.—Galloway ponies existed probably from time immemorial in that region of Scotland from which they took their name. They are supposed by some to have sprung from Spanish horses which swam ashore from a ship of the Armada, which had been wrecked on the coast of Galloway, but this theory is not well supported or generally accepted. The probability is that they were an ancient native breed. They were remarkable for their symmetry of shape and docility of disposition; and it is said they were so much esteemed at home, and so much coveted elsewhere, that it became necessary for certain of the Scottish kings to restrict their exportation. 'Maxwell's veteran chief', as Burns calls him—great-great-grandfather of the present Mr. Maxwell of Munches—writing in 1811, when he was in his ninety-first year, tells of a 'handsome Galloway' which a tenant farmer, accused of rioting in 1723, gave to the presiding justice, and thereby secured his acquittal. It has been suggested, but possibly on only slender authority, that it was a Galloway pony on which King Robert the Bruce rode at Bannockburn. Be that as it may, the Galloway was a hardy, active, and exceedingly useful horse. He was like a typical Clydesdale in miniature, being from 14 to 15 hands in height. His legs were clean, with a tuft of hair at the pastern joint. In the saddle, the cart, and the plough he gave a good account of himself, and in the folklore of Galloway there are not a few traditions which show the affection with which the little horse was regarded. When railways were unknown, and roads were fewer and worse than they are now, the Galloway had many a long journey to make over hill and dale, for provisions for his master's household. These he often had to carry with his owner on his back, and sometimes crossing bogs and mosses he would sink, almost to the middle. An accident like this happened to a Galloway pony ridden by the grandfather of the present writer. The pony sunk deeper and deeper in the moss, each plunge making matters worse. At length the rider, giving up hope of getting the animal out at all, left it. Hearing a pitiful 'whinny' when a short distance away, he returned, and as a last resort threw his plaid immediately in front of the pony. By a tremendous effort it managed to get its fore feet on to the plaid, and thus secured sufficient footing to bring it to 'terra firma', much to the joy of its master.

Probably about a hundred years ago Galloways began to be crossed with Clydesdales and other breeds, and the real Galloway pony is not now to be met with in the south-west of Scotland. The Highland pony, however, is a near relative, and in Yorkshire and other districts of England the Galloway is known to this day.

The disappearance of such an interesting type of animal from his native district is much to be regretted, but the present-day conditions of agriculture in Galloway require heavier and more powerful horses. All the same, for many reasons we are inclined to agree with William Nicholson, the Galloway poet (born at Borgue, 1783), when he wrote of a favourite pony:

> Yet though he 's ill, and ill eneugh,
> I ne'er saw ony in the pleugh,
> When ridin' through the bent and heather,
> That I wad gie the tane for t'ither'.

[W. B.]

Galls.—A plant gall results from increased growth or hypertrophy as opposed to atrophy or checked growth. The growth is generally local, so that the gall appears as a swelling or protuberance. Gall formation is the result of a stimulus (insect, &c.) and a reaction on the part of the plant, the latter supplying the material necessary for the swelling. Simple galls arise when insects pierce and suck young plant tissues (see APHIDES). More complex galls, such as those on Oak, are generally occupied by an insect larva (*Cynips*, &c.). Bud-galls, as in the case of Black Currant, are induced by minute insects (see ERIOPHYES RIBIS). Several forms of root-galls are due to eel-worms (Nematodes). Fungi may be accompanied by gall formation, the growths varying from small pustules to large swellings (see FINGER-AND-TOE). The tubercles on roots of Leguminosæ and other plants are also galls. [W. G. S.]

Gallstones.—The occurrence of gallstones in animals is rare; horses, having no gall bladder, escape them almost entirely; while cattle, sheep, and swine are not prone to them save as a result of parasitism, when the biliary fluid is thickened, and a deposit of salts leads to an agglomeration of debris, cholesterine, and bilirubinate of lime, and thickened epithelial products, caused by the presence of parasites acting as foreign bodies. They are comparatively soft in texture, yet hard enough to occlude the duct in which they may be situated. Colicky pains of uncertain duration have been noted during life, but there are no specially diagnostic symptoms in animals. [H. L.]

Galtonia, a small genus of Liliaceæ related to Hyacinthus. The only species grown is *G. candicans*, a native of South Africa. It has a large bulb, long, green, fleshy, strap-shaped leaves, and a stout, erect scape a yard or so high, bearing numerous elegant drooping white bell-shaped flowers arranged candelabra-fashion. It is sufficiently hardy to live permanently out-of-doors in a sheltered border. In Holland the bulbs are largely grown for use in summer bedding, the flowers being very effective when grown in combination with Gladioli or Scarlet Verbena. [W. W.]

Gamasidæ, a family of acari or mites. The most important is the Red Hen Mite of poultry (*Dermanyssus avium*). Although this mite is essentially a bird pest, it is now and then found on the horse, ox, dog, cat; but the parasitism is accidental, the acari having come from poultry or some wild birds.

This pest may be found in nearly all unclean poultry houses, where it causes much annoyance and loss. It is provided with a piercing and sucking snout, with which it punctures the skin. The size varies, but it is somewhere about ·60 mm. in length, pale dull-yellowish to deep-red, with eight legs. The fowl mite is most prolific, and the young hatch out very rapidly into little white six-legged mites. These larvæ frequently cast their skin, and the cast skins remain behind as a silvery powder, often seen on the roosting perches and in crevices in the nests. They feed at night, and hide away in any crevices, &c., during the day. They have a great dislike to light, air, and cleanliness, and love damp, dark, and badly ventilated roosts. In nests where straw is used one may find them in all stages, eggs, larvæ, and copulating adults. Reproduction is mainly in spring and summer. If birds, especially setting hens, are found to be restless and not thriving, they should be examined at night to see if this mite is present, and then treatment should at once be carried out. A good dusting with pyrethrum is best for this purpose. The main thing to aim at, however, is to clean out the house—nesting boxes, perches, and all. Limewash, with some paraffin in it, should be used over the walls. Perches and nesting boxes should be movable, so that they be taken out and scalded every now and again, or treated with some substance such as paraffin or creosote. The annoyance caused to setting hens is such that they frequently forsake the nest. It is very desirable, therefore, that clean setting boxes are used, in clean places. [F. V. T.]

Game. See GAME LAWS, GAME PRESERVATION, &c.

Game—Damage to Crops. See GAME PRESERVATION, EFFECTS OF.

Game—Damage to Woodlands.—Game in woodlands may often cause very serious damage, and all the more so as most of our British woods are formed and managed far more for ornament, sport, and shelter, than with a view to being worked mainly on business principles. Indeed, in some parts of the country the shooting rents are often higher than the ordinary profit derivable from woodlands. With regard to damage to woodlands, game may be classed in three categories: (1) big game, including red, fallow, and roe deer; (2) ground game, or hares and rabbits; and (3) feathered game. As British deer forests consist only of great heathery wastes, there can be no extensive damage in woods, such as is caused on the Continent by the deer browsing on buds and young shoots, or gnawing the bark of poles in winter, and bark-stripping in spring and summer; although wherever saplings and poles are to be found they are used as fraying stocks by the stags in summer, softwoods being naturally selected for this purpose. Fallow deer do little damage to trees in Britain, whether in parks or in the open forest. But roebucks are often very destructive in young plantations. At Scone, Perthshire, in 1900, they were even found to make use of fence steps 5½ ft. high, leading over wire fencing against rabbits, in going to and from a young plantation. They soon acquire a habit of nibbling Larch, Silver Fir, Weymouth Pine, &c., interplanted among Common Pine or Spruce; and such trees, as well as ornamental specimens, can often be very simply protected by tying in autumn, with rushes or thread, small bits of newspaper, about 4 to 6 in. square, below the top cluster bud of the leading shoot of plants about 2 to 3 ft. high. But unless nurseries are protected by a high fence, roedeer can easily leap over and do much damage during the winter months. Ground game, however, and especially rabbits, cause by far the most damage in British woods and plantations. Hares, being larger, can

individually do more damage than rabbits; but they are much more easily kept in check, and are far fewer in number than the voracious and very prolific burrowing rabbit, which, so far as economic forestry is concerned, ought to be degraded from the rank of game and really classed as vermin. During every winter it causes serious damage in coppices and plantations. Rabbits multiply quickly, and wherever they are numerous they seem to gnaw everything in the underwoods except the Common Rhododendron (*Rhododendron ponticum*), sometimes almost entirely ruining hazel and ash coppices while snow is lying on the ground. They also do a vast amount of damage in young plantations up to six or seven years of age, the only young tree that seems to be at all distasteful to them being the rough-barked Corsican Pine. And in hard winters they gnaw the bark and often kill outright even large park trees, the only kinds that are exempt from their attacks being apparently the old thick-barked Oak among broad-leaved trees and Corsican Pine among conifers. Tarry and other similar mixtures (smearoleum, &c.) are prepared for coating the buds and shoots as a protection, but such means cannot be relied on; wire-net fencing is the only effective plan which has a fair chance of success, though it occasions considerable extra expense if the plantation be small. Originally netting with a 2-in. mesh was sufficient; but now a 1-in. mesh is needed for the lower 18 in. (besides 6 in. being bent outwards underground to prevent burrowing), and $1\frac{1}{4}$ or $1\frac{1}{2}$ in. mesh netting for 2 ft. above that, and set slantingly or bent outwards at the top to prevent climbing over. These precautions about bending outwards underground and at the top are now absolutely necessary, as in many localities (*e.g.* at Scone) rabbits have, since the introduction of close-meshed wire-net fencing, developed climbing powers, and have been seen thus making their way into plantations. And when once they get inside wire-fenced plantations these very soon get ruined and become warrens. [J. N.]

Game Coverts.—When old woodlands become open, the soil usually gets overrun with self-sown underwood and shrubs, or by a dense growth of weeds like bracken, broom, brambles, nettles, coarse grasses, &c. In many cases this rough tangle of spontaneous undergrowth forms excellent natural cover for game, keeping it warm and dry, and helping to provide rough feeding. For most kinds of game the best covert is that which is kept quiet, lies dry, has a mixture of hazel, holly, young conifers, bracken, and gorse; and for woodcock, a good feeding ground within convenient distance. But in many cases more or less of artificial assistance is necessary in order to improve the existing conditions in favour of game; and this is best given in the form of planting, the preference being, of course, given to evergreen shrubs, and particularly to those which furnish edible fruits for the game. Where underplanting of middle-aged woods of Larch, Pine, or other light-demanding trees has been carried out with shade-enduring spruces, silver firs, &c., these latter make good dry shelter, and are thus equally valuable for game protection as for timber-growing. But where underwood is desired specially for game cover and ornament, it is of course desirable to arrange for the introduction of well-placed groups of such shrubs as privets, laurels, hawthorn, holly, blackthorn, buckthorn, dogwood, elder, barberry, and juniper, broom, euonymus, &c., throughout the wood, and to plant the more open patches and the edges of the rides and drives with the more ornamental low-growing shrubs like rhododendrons, azaleas, aucubas, cotoneasters, laurustinus, mahonia, philadelphus, snowberry, spiræa, and similar kinds, not forgetting the beautiful North American flowering currant (*Ribes sanguineus*), whose steel-blue berries are much relished by pheasants, as are also the fruits of *Leycesteria formosa*. By a careful selection and arrangement of evergreens, fine effects can be produced in winter, when they contrast well with the bare trees in the leafless woodlands. The beauty of such woodland rides and drives can also be easily enhanced by planting roses, sweetbrier, honeysuckle, &c., here and there. The evergreen privet in large groups in the woods themselves, and rhododendrons along the margins (especially the Common Red, *R. ponticum*, the hardiest species of this genus), are perhaps the favourite and the most common shrubs used in this respect; and one of the most extensive examples of the latter kind of cultivation is the main shooting drive, about 2 miles in length, running through the conifer woods on the Marquis of Waterford's estate of Curraghmore (Co. Waterford). And this hardy and beautiful rhododendron has the additional advantage of being, like the common privet, practically almost immune from attack by the omnivorous rabbit. In some localities, however, the rhododendrons are being replaced by bracken, broom, and bramble. [J. N.]

Game Fowl.—For nearly two thousand years cock-fighting was a recognized sport in this country, and many of the greatest in the land indulged in it. Cockpits were common everywhere, and large sums of money were staked on the results, whilst the breeding of these game fowls was carried on with the greatest skill and care. The pursuit was prohibited in 1848, but mains are still fought surreptitiously, as the newspapers tell. In Asia it is common, and to some extent in America.

The fighting Game was a stout-bodied fowl with powerful limbs, yet active, firm in flesh, and with large wings. The last named were as necessary as strong lower limbs, and consequently cock-fighters unconsciously developed the breast muscles, as these work the wings, and increased the flesh on that part of the body, though hard flesh was the result. The oldfashioned type of Game Fowl carries a large quantity of breast meat, but when killed it needs to be hung well before it is cooked, otherwise the flesh is too close. With the prohibition of cock-fighting and the rise of exhibitions a great change gradually took place, in that the birds were bred much longer in leg, neck, and head, the size of body was proportionally reduced, and instead of the large wings and

full, flowing tail, short wings and what are called whip tails became common. Within recent years the older type has become more popular, so that to-day there are two kinds—the old fighting and the modern Game, the latter useless in the pit, and bred only for exhibition.

Practically the Game Fowl is of small value by reason of its pugnacious nature, making the keeping together of considerable numbers difficult. They are, therefore, chiefly used to cross with soft-fleshed races to produce table chickens. Many hens are very good layers, and the eggs are rich in flavour. There is a large number of varieties or colours, such as black-reds, brown-reds, piles, duckwings, spangled, &c. [E. B.]

Gamekeeper, Duties of.—None of the offices connected with field sports has undergone such a rapid and recent revolution in the character of its duties as that of the gamekeeper. The huntsman, the coachman, the fisherman of to-day have much the same functions to perform as their predecessors of a century ago; but breech-loading guns, hand rearing of pheasants, and driving game over the guns instead of shooting it over dogs have completely altered the character of the sport. While opinions differ as to the relative merits of the old and new styles, all agree that, besides activity, temperance, and fidelity, the modern gamekeeper must exhibit other qualities which were not essential in his prototype of half a century ago. The old-fashioned gamekeeper enjoyed periods of comparative leisure such as cannot be had now. The summer months, which used to be devoted to the breeding and training of pointers and setters, are now occupied by the incessant labour of rearing young pheasants. In winter, although the sport, which used to be spread over the whole season, is now generally concentrated into a few big days, vigilance of watching must increase in proportion to the larger stock of game. In grouse and partridge driving, the head keeper takes command of a small battalion of beaters and drives the birds over a line of eight or ten guns, an operation calling for the exercise of a high degree of skill, decision, and discipline. The only dogs employed are retrievers, the excellence of which, and the way in which they are handled, afford a main criterion of the gamekeeper's qualifications.

Gentlemen taking part in one great battue after another in different places, whether in cover or the open, do not always give credit for the amount of patient routine and hard work undertaken to ensure satisfactory results. Large estates are divided into separate beats, each in charge of an under keeper, who, besides the ordinary duty of watching, killing vermin, and training his retriever, should know all the nests of game birds on his ground, and make written report upon the same to the head keeper, thereby enabling him to form an estimate of the stock at the beginning of the shooting season. Discrimination should be exercised in the destruction of vermin, a term which too often is made to include harmless, and even beneficial, species. The chief mammals to be rightly dealt with as vermin are cats, foxes (where there are no hounds), stoats, hedgehogs, and, above all, rats; while among birds, magpies, sparrow hawks, and peregrine falcons are the chief pirates. Jays, so universally condemned, never go into the open; wherefore, now that the stock of pheasants depends so exclusively upon hand rearing, the woodland depredations of these beautiful birds are of little account in the result. It is hard to persuade keepers that owls and kestrels, though occasionally depraved by the abundance of young chicks about the coops, are really beneficial both to farmers and game preservers by reason of the vast number of rats and mice which they destroy.

Tact and good temper are indispensable qualities in a gamekeeper, to enable him to keep on good terms with farmers, upon whose goodwill all success in game preserving ultimately depends. The keeper should certainly be keen and earnest in his work, but should regulate it as much as possible so as not to injure other legitimate interests involved. [H. M.]

Game Laws.—The value, for purposes of sport, and, in a minor degree, of those wild animals usually comprised under the term 'Game", as articles of human consumption, made them at a very early date the subject of special legislation in this country, and thus gave rise to the long series of statutes known as the Game Laws.

At common law, animals which are wild by nature cannot become the property of anyone until they have been reduced into possession, consequently the appropriation of them in their wild state is not an act of theft. But a consideration of the evils likely to arise from trespass and the doctrine of the landowner's right to the exclusive possession of his land, have given rise to the restrictions on the appropriation of game imposed by the Game Laws. In England there is not now any property qualification necessary to entitle a person to kill game. In Scotland, however, the old Act of 1621 is still in force, whereby it is enacted that no one can kill game who is not the owner of a ploughgate of land (about 100 ac.) situate in Scotland. In Ireland no one, unless he owns freehold land of the yearly value of £40, or personal estate of the value of £1000, can kill hares, pheasants, partridges, grouse, or quail. Of course anyone who has the necessary qualification may authorize another to shoot over his land. The right of shooting and sporting is, in England, an incident of the occupancy of land, while in Scotland it is an incident of the ownership. Consequently in England, apart from express reservation, the right of sporting is in the tenant, whereas in Scotland, apart from agreement, the right is implicitly reserved to the landlord in all agricultural leases. (See below for modifications introduced by the Ground Game Acts.) The definition of game is not uniform for the United Kingdom, but the definition of game in the Night Poaching Act applies to the whole of the kingdom, and includes hares, pheasants, partridges, grouse, ptarmigan, black game, and bustards. In addition, the following animals are for certain purposes included in the term in various other Acts, viz. capercailzie, landrail, quail, snipe, woodcock, deer, hares, and rabbits.

The general purpose of the Game Laws was originally twofold: (1) to prevent trespass by unauthorized parties on the lands of others in pursuit of game, and (2) to provide for the preservation of game by the enforcement of close seasons. Subsequently, provision was made for the collection of excise duty by means of licences imposed on persons taking game, dealing in it, &c. The most recent legislation, however, has proceeded on a different basis, namely, the protection of the agriculturist against the ravages of game.

1. Prevention of Poaching.—The legislature has distinguished between the offences of night and day poaching in the severity of the penalty attached to the offence, since it has averred that in the case of night trespass there was more danger 'of murder and other grievous offences being caused by persons going armed by night for the destruction of game'. The principal night-poaching Act is the Act of 1828 (9 Geo. IV, c. 69), which imposes penalties on any person who, by night, on any land open or enclosed, unlawfully takes or destroys game or rabbits, or enters thereon with any instrument for the killing of game. It will be observed that while the killing of rabbits is an offence, the entering or being on land with any instrument is not an offence, unless for the purpose of killing game, rabbits not being mentioned. It is therefore necessary under the second head to prove the intention to kill game. Anyone unlawfully entering may be prosecuted, and while in England a tenant would be liable for 'unlawfully taking' game, he could not be prosecuted for being on his own farm at night for the purpose of taking game. But in Scotland it has been held that he could be convicted of being unlawfully on his own farm at night for the purpose of killing game, whereas he could not be convicted of such an offence under the Day Trespass Act. If more than one person is in company, of whom only one has an instrument for the killing or taking of game, all are liable to the penalties. Owners or occupiers of the land on which the trespass is committed, or their servants, may apprehend offenders, who, if they offer violence with any offensive weapon, are liable to severe penalties.

As it was found that this Act was evaded by armed persons taking by night game and rabbits on public and other roads, and at gates, outlets, and openings between lands, which were not included in the Act, the Act of 1844 (7 & 8 Vic. c. 29) was passed. By this Act all the penalties enacted by the former Act are imposed on persons who by night unlawfully take or destroy game or rabbits on any public road, highway, or path, or the sides thereof, or at openings, outlets, or gates from any land on to such roads or paths. Under this Act the game must be actually taken, since the mere being on a road with an instrument for taking or killing game is not an offence.

For the purposes of the Night Poaching Acts, night is 'declared to commence at the expiration of the first hour after sunset, and to conclude at the beginning of the last hour before sunrise'. The time is computed by Greenwich mean time. Proceedings under these Acts must be commenced within six calendar months after the commission of the offence in the case of summary trials, and twelve months in the case of indictable offences.

In 1831 the Game Act (1 & 2 Will. IV, c. 32), applicable to England, and in 1832 the Day Trespass Act (2 & 3 Will. IV, c. 68), applicable to Scotland, were passed for the purpose of preventing trespass by day by persons unlawfully engaged in the pursuit of game The offence is committed by anyone entering or being upon land without the leave of the proprietor, in pursuit of game, &c. In England a constructive entry is not sufficient to warrant a conviction under this Act, there must be actual personal trespass. But as the solum of a road usually belongs to the adjoining proprietor or proprietors, a person using the road for the purpose of shooting on to the lands of another would usually be liable as a trespasser. Moreover, where there are several in the party, some of whom enter the lands, the others remaining outside to give the alarm are equally guilty of entering. In Scotland actual bodily entry on the lands is not, however, in all cases requisite, for it has been held that an offence under the Act may be committed by remaining on a public road and sending a dog on to the land in pursuit of game, or by shooting on to the lands from the road without actual entry on to them. As already mentioned, it has been decided in Scotland that under this Act a farmer cannot be convicted of a statutory trespass on his own farm, although, as already pointed out, the opposite has been decided when the act was by night. The two decisions are difficult to reconcile. A person may be lawfully on the land and yet commit an offence under the Act by unlawfully taking game when there. Thus the servant of an agricultural tenant may be convicted under the Act, although his master cannot. Again, one who has written permission to kill rabbits may contravene the Act by killing game.

Trespassers in pursuit of game may be required to quit the land and to give their Christian names, surnames, and places of abode, and in case of refusal or of giving an illusory address, they may be arrested by anyone having the right of killing game on the land, or their gamekeepers, servants, or other persons authorized by either of them.

For the purposes of the Acts, daytime shall be deemed to commence at the beginning of the last hour before sunrise, and to conclude at the expiration of the first hour after sunset. The Acts do not apply to persons hunting or coursing deer, hares, or foxes started on other land, or in Scotland on other land upon which such persons were entitled to hunt or course. But these Acts do not prevent the owner or occupier resorting to his common-law rights to prevent trespass, although the two remedies cannot be used by the same person for the same offence.

Under this Act the game found in the possession of the trespasser may be demanded, and in case of refusal to deliver, may be taken from him.

The Poaching Prevention Act, 1862 (25 & 26 Vic. c. 114), provides additional remedies for the prevention of poaching. By this Act, power

is given to any constable or peace officer, in any highway, street, or public place, to search any person whom he may have good cause to suspect of coming from any land where he was unlawfully in pursuit of game, or any person aiding or abetting him, and having in his possession any game unlawfully obtained, or any gun, part of a gun, or nets or engines used for killing or taking game, and also to stop and search any cart or conveyance in which such constable shall have good cause to suspect that any such game or such article is being carried by any such person, and if he (the constable, &c.) finds such game or article, to seize and detain it.

The constable cannot apprehend the person on whom the game is found, but must apply for a summons. If convicted, in addition to the penalty imposed, the game and the gun, nets, or other implements shall be forfeited, but if no conviction takes place they must be restored to the person from whom they were seized.

For the purposes of the Act, game includes hares, pheasants, partridges, eggs of pheasants and partridges, woodcock, snipe, rabbits, grouse, black or moor game, and eggs of grouse, black or moor game. This is the only Act applicable to Scotland where eggs are treated as game, though in England there are other Acts which make similar provisions.

2. Close Seasons.—In order to provide for the preservation of game, close seasons have been provided by the legislature, during which the killing or taking of game is illegal. The principal close seasons of the year are as follows: Grouse, 10th December to 12th August; black game in England (except Somerset, Devon, and New Forest), Scotland, and Ireland, 10th December to 20th August; in Somerset, Devon, and New Forest, 10th December to 1st September; partridge, 1st February to 1st September; pheasant, 1st February to 1st October; snipe, wild duck, woodcock, &c., and all wild birds, 1st March to 1st August. In each case the days mentioned are excluded. In England and Scotland there is no close season for killing hares or rabbits, but hares may not be sold during the months of March, April, May, June, and July. In Ireland it is illegal to kill hares between April 20th and August 12th (see 'Ground Game Act' below). In England and Ireland it is illegal to kill game on Sundays at any season of the year, and in England it is illegal to kill game on Christmas Day. In England, rabbits, but not hares, may be killed on Sunday and Christmas Day; in Ireland, ground game may not be killed on Sunday. In Scotland there is no prohibition against killing game on any particular day. Game, including hares and rabbits, cannot be shot at night. In order to prevent the destruction of game by the annual burning of heather and withered grass so common in high pasture land, it is provided by the Game (Scotland) Act, 1772, that in Scotland no one shall make muirburn or set fire to any heath or muir between 11th April and 1st November, except in the case of high and wet muirlands, which the proprietor, or the occupier, with the written consent of the proprietor or his factor, may burn on till 25th April. In the case of a tenant, the writing authorizing the burning must, previous to such burning, be recorded in the sheriff court books of the county. In Ireland it is provided that no person shall burn any heath, fern, &c., at any season of the year, save only between the 14th day of June and the 2nd day of February.

Since 1869 a series of statutes has been passed to provide protection for wild birds which do not fall under the category of game. The earlier Acts have been repealed, and the principal Acts now in force are:—

The Wild Birds Protection Act, 1880 (43 & 44 Vic. c. 35).

The Wild Birds Protection Act, 1881 (44 & 45 Vic. c. 51).

The Wild Birds Protection Act, 1894 (57 & 58 Vic. c. 24).

The Wild Birds Protection Act, 1896 (59 & 60 Vic. c. 56)

The Wild Birds Protection Act, 1902 (2 Edw. 7. c. 6).

The Wild Birds Protection Act, 1904 (4 Edw. 7, c. 4).

Generally speaking, the close time is from 1st March to 1st August, and the Acts apply to all wild birds. In the schedule to the Acts, however, certain birds are included, and as regards all birds not scheduled, the owner or occupier of land, or anyone authorized by him, can kill them at any time on the ground so owned or occupied by him. No one who is not an owner or occupier of land, or duly authorized by such, can shoot or take any wild bird, whether scheduled or not, during the close time.

The Secretary for Scotland, on the application of the County Council, may, by order, schedule additional birds or prohibit the taking of the eggs of wild birds, and he may vary the close time, or make it extend in the case of particular birds to the whole year. To attempt to specify the birds thus scheduled, or the various close times in force, would be out of the question, since orders have been issued applying to almost every county in England and Scotland, in which the provisions of the Acts have been more or less varied. See art. Birds, Protection of Wild.

3. The Ground Game Acts.—In order to afford more adequate protection to tenants from the depredation of ground game, provision has been made by the Ground Game Act of 1880, the Ground Game (Amendment) Act, 1906, and the Agricultural Holdings Act of 1908 (which came into force on 1st January, 1909). By the Ground Game Act of 1880 it is provided that every occupier of land shall have, as incident to and inseparable from his occupation of the land, the right to kill and take hares and rabbits thereon concurrently with any other person who may be entitled to kill and take ground game on the same land. The term 'occupier' is not defined, but it would appear from the preamble that it would extend only to an occupier for the cultivation of the soil, and that a tenant of land for other purposes would not be entitled to the benefit of the Act. The authorities differ in opinion as to whether the Act would extend to joint tenants. Where the occupier sublets his land, the right to ground

game is in the sub-tenant and not in the tenant. A person shall not be deemed to be an occupier in the sense of the Act if he has merely the right of common over the lands, or takes them for grazing sheep, cattle, or horses for a period of not more than nine months. Thus, where grass parks or the policies round a house are let to a grazier for a period of not more than nine months, the grazier has no right to kill ground game. In Scotland it has been decided, in a case in the sheriff court, that where parks were let for 'the season' this amounted to a lease for a period of not more than nine months, and the tenant could not claim the benefit of the Act. The right conferred on the tenant is only concurrent with that of any other person who is entitled to kill ground game. Consequently the landlord may still kill ground game or let the right to a third party. The right conferred is, however, subject to certain limitations: (*a*) The occupier shall kill or take ground game only by himself or by persons duly authorized by him *in writing*. (*b*) The only persons to whom the occupier may delegate the power to kill or take ground game are: (1) members of his household resident on the land in his occupation. The members of the household must be resident on the land. Therefore in the case of a farm where neither the tenant nor any member of his family is resident the authority cannot be granted, but if a member of his family be resident on the farm there seems no reason why the tenant may not grant authority to that member, though he himself personally resides elsewhere. In Scotland the opinion has been indicated that the term 'member of household' will include a visitor asked to stay a week and shoot rabbits, but the point was not expressly raised, and the soundness of the opinion has been gravely doubted. (2) Persons in his ordinary service on such land. Ordinary servants only can be authorized, thus excluding such casual workers as harvesters, &c. Moreover, the servants must be employed on the ground on which the game is to be killed. (3) One other person *bona fide* employed for reward to destroy ground game. Questions have been raised as to what constitutes reward in the sense of the Act. In practice it is believed that an arrangement whereby the game killed is kept as reward will fulfil the requirements of the Act, and there is a decision in the Scotch courts which indirectly supports this view. But in view of the way in which the question presented itself to the higher court, the point cannot be held to be definitely settled. Of these persons, however, only the occupier and one other person authorized in writing, and answering to one or other of the above descriptions, may kill the game with firearms.

The mere fact of a person having the occupier's written authority is not sufficient, unless he be either a member of the occupier's household resident on the farm, an ordinary servant, or a person *bona fide* employed for reward. Failing his satisfying these requirements, he may be prosecuted for trespass.

Every person so authorized by the occupier, on demand by any person having a concurrent right to take game, or any person *authorized by him in writing* to make such demand, must produce his authority. This requirement is imperative; the giving of name and address is not sufficient, and if the authority is not produced when demanded, even though it exist and has been left at home, it would not be a good defence to a prosecution. The Act expressly provides that failure to produce the authority when demanded shall have the result of making the person so failing an unauthorized person. The demand can, however, only be made by the landlord or game tenant, or someone duly authorized by them in writing to make the demand. The person authorized in writing to make the demand is not obliged by the Act to produce his own written authority, but he ought to have it with him and to produce it when making the demand.

(*c*) *Restrictions in Case of Moorlands.*—In the case of moorlands and unenclosed lands (not being arable lands), the occupier and the persons authorized by him shall exercise the rights conferred by this section only from the 11th day of December in one year until the 31st day of March in the next year, both inclusive; but this provision shall not apply to detached portions of moorlands or unenclosed lands adjoining arable lands, where such detached portion of moorlands or unenclosed lands are less than 25 ac. in extent. By the Ground Game (Amendment) Act, 1906, which came into force on 1st April, 1907, the right of occupiers of moorlands, &c., is extended so as to give them the right to kill ground game on such lands from 1st September to 10th December, both inclusive, but only '*otherwise than by the use of firearms*'.

The rights conferred by the Act are inseparable from occupancy, and if a landlord who is farming his own land lets the sporting rights, he is not thereby debarred from killing ground game in terms of the Act. The right is inalienable, and any agreement which purports to divest or alienate the occupier's right, or gives him any advantage in consideration of his forbearing to exercise it, or imposes any disadvantage in consequence of his exercising it, is declared to be void. Nor may the right be interfered with or obstructed. Thus, in a Scotch case where it was alleged that a keeper was trampling down and destroying snares or traps set by farmers, was sprinkling paraffin in such proximity to their traps as to prevent ground game being taken, and otherwise obstructing them in the exercise of their rights under the Act, interdict was granted against the keeper.

While the effect of this section is to make void all agreements in contravention of the occupier's right to destroy ground game, the Ground Game Amendment Act, 1906, provides that this section shall not operate to prevent the occupier of moorlands and unenclosed lands, and the owner of such lands or other person having a right to kill game thereon, from making agreements for the joint exercise of the right to kill ground game between 1st September and 10th December in any year.

The occupier and the persons duly authorized by him do not require a game licence to kill ground game, but a gun licence is still necessary

even to kill rabbits, which are not vermin in the meaning of the Gun Licence Act, 1870. The occupier has the same power of selling ground game killed by him or the persons authorized by him as if he had a game licence. This privilege, however, does not extend to the *persons authorized by him to kill ground game.*

No person having a right of killing ground game under this Act or otherwise shall use any firearms for the purpose of killing ground game between the expiration of the first hour after sunset and the commencement of the last hour before sunrise.

Spring traps for killing rabbits can only be set in the rabbit holes. This in Scotland has been interpreted to mean under the roof of the burrow and not on the scrape in front of it, and it has been held that the setting of traps from 7 to 16 in. from the mouth of the hole was a contravention of the Act. It has also been decided that the term 'rabbit hole' means a rabbit burrow, and that therefore a hole scraped by rabbits to get under wire netting does not come within the term.

The Act prohibits the use of poison for killing ground game. But apart from this Act the use of poison for killing game of any kind is illegal. By the Poisoned Grain Prohibition Act, 1863 (26 and 27 Vic. c. 113), and the Poisoned Flesh Prohibition Act, 1864 (27 and 28 Vic. c. 115), anyone who sells, or sows or places, or causes to be sown or placed on any exposed place, any grain, seed, or meal which has been steeped in poison so as to be dangerous to life, or who knowingly or wilfully lays, or causes to be laid, any poisoned flesh on any land, is liable in a penalty of £10. But the laying of poisoned flesh in a dwelling-house or other building, or in a garden, or in the drains of a house, provided the drains are so protected by gratings as to prevent a dog getting into them, is permissible for the destruction of small vermin.

The prohibitions against night shooting, placing of spring traps, except in rabbit holes, and the use of poison, applies to persons having the right under this Act 'or otherwise' of killing ground game. In Scotland the opinion has been expressed that the words 'or otherwise' would include the landlord or game tenant as well as the farmer. The same point came up in another case, but the judges reserved their opinion, and therefore the question cannot be said to be authoritatively settled. In England, however, it has been decided that in spite of these words the prohibitions do not apply to owners in possession.

The Ground Game Acts were passed to protect occupiers of land from the ravages of *ground* game, but they confer no right to take other game. Where the tenant suffers damage from other game, he can claim damages only if he prove that the stock of game on the ground at the commencement of the tenancy has been increased to an excessive extent, a claim somewhat difficult to substantiate. This difficulty has been met since 1st January, 1909, by section 9 of the Agricultural Holdings Act, 1908. The following are the provisions of the section:—

'Where damage to crops is done by game which the tenant has not the right to kill, *i.e.* other than ground game, the tenant is entitled to compensation under the following conditions:—

(1) The damage must exceed 1*s.* per acre of the area over which the damage extends.

(2) Written notice must be given as soon as possible *after damage first observed.*

(3) Landlord must have reasonable opportunity to examine damage.

(*a*) In case of a growing crop, before it is raised, reaped, or consumed; and

(*b*) In case of raised or reaped crop, before removal from the ground.

(4) Written particulars of the claim to be given within one month of expiry of the year for which the claim is made.

Failing agreement, the damage shall be settled by arbitration. In cases of leases current at 1st January, 1909, deduction from the compensation shall be made for any sum or allowance in respect of game damage expressly fixed by the lease. After the date of the Act any agreement in limitation of the compensation fixed by the Act shall be void.

The landlord is liable in the first instance to the tenant, but is entitled to be indemnified by his game tenant if any.

For purposes of the Act, game means deer, pheasants, partridges, grouse, and black game.

4. Licences.—Everyone who uses a gun must have either a game licence or a gun licence, and in some cases must have both. Moreover, if a gamekeeper be employed a licence is necessary, and so also for dogs. See Licences.

[D. B.]

Game Licence. See Licences

Game Preservation, Effects of.—[Though the facts and statistics here given are by no means recent, they still retain their interest and value, and the article, with some omissions, is reprinted on account of its eminent author. It was originally written for Morton's Cyclopedia of Agriculture.]

Of the amount and nature of the damage sustained by farmers from the ravages of game, we have abundant and conclusive proof. Hares and rabbits will eat almost every description of agricultural produce. Witnesses concur in stating that the seed crops suffer from seedtime even up to harvest. Hares eat the tender blades, and thus retard the growth of grain, and cause it to come to maturity later than would otherwise be the case; and the consequence is that the quality of the grain is often deteriorated. They bite off the wheat at the knots or joints, for the sake, it is supposed, of the saccharine matter found there as the grain approaches to maturity. The green crops are also injured to a great extent. Turnips, for example, are bitten by hares and rabbits; and the outer skin being broken, they are soon destroyed by frost. Not unfrequently the growth of certain articles, such as winter vetches or carrots, has been abandoned altogether from the impossibility of raising a crop in the face of the game ravages to which they were subjected. Hares commit very great injury by cutting for themselves tracks or pathways through the standing corn. These will sometimes be from 1 ft. to 2 ft. wide, leaving

the straw as an old stubble, in the fields where the crop is not yet reaped.

We must specially advert to the *amount* of damage which arises from the presence of game in preserved districts. It is remarkable that although the tenant farmers who were witnesses before Mr. Bright's Committee in 1846 were brought from almost every part of the kingdom, their evidence was strikingly in harmony on the main points of the game controversy. For instance, Mr. B., farming in Hertfordshire, detailed the particulars of damage on his farm, and gave in an award drawn up by two arbitrators, in which the injury committed by the game during one season, on land not exceeding 35 ac., was upwards of £118. He stated also that the damage he sustained on the whole of his farm was equal to an increased rent of £200 per year.

Mr. C., farming more than 3000 ac., arable and sheepwalk, in the county of Norfolk, stated that in the year 1844 he was a loser of nearly £1000 by the damage done by game. The greatest damage was in the wheat crop, but grass and sainfoin also were much injured. At the commencement of his lease, about 500 hares were killed yearly; but 'last year they killed, at ——, 2500 hares, and I consider that 2000 of them were maintained by myself, my farm being nearer to the cover than the rest of the parish'.

Two other cases of damage may be quoted, one from the county of Derby, and the other from Fifeshire in Scotland. Mr. Gauntley of Bakewell stated to the Committee that on an estate in Derbyshire consisting of 3770 ac., of which only 400 ac. were arable land, the game damage was estimated in the year 1843, on 395 ac. of arable land, at £897; and in 1844, on 389 ac., it was ascertained to have been £916. Here the average injury was 46*s.* per acre on the whole of the corn land. Mr. Landale, residing near Kirkcaldy, stated that he had made valuations for ten years on portions of an estate in the county of Fife. The estimate of damage on 1059 Scotch acres in 1839 was £428; in 1840 it was £320; in 1841, £655; in 1843, £400; in 1844 it was near £1000: the estimate of the two last years being made by another valuer.

With regard to winged game, the evidence established the fact that much injury is sustained, especially from pheasants. On a farm in Hertfordshire, a single hen pheasant, during the months of March and April, 1845, destroyed as much of a piece of beans as amounted altogether to ¼ ac. before she could be trapped. In this instance the pheasant found shelter in an adjoining wood. The bird pulled up the plants when they were about 2 in. high, that she might get at the bean at the root.

The question as to the amount of produce consumed by hares, as compared with that consumed by sheep, has been often discussed; and it may be well here to give the particulars of a very interesting, and, we think, conclusive experiment, tried by Mr. George Gayford, of Rymer House, near Thetford. It was unavoidably confined to the question of food *consumed* —the quantity *wasted* by hares and rabbits seems incapable of accurate determination. Mr. Gayford divided a large outhouse; at one end he shut up two Down hogget sheep, and at the other twelve tame rabbits of a large size, being about equal in size and weight to hares. He measured and weighed the food given to the rabbits and the sheep; such food consisting of oats, bran, carrots, swede turnips, and cut sainfoin. Both were fed alike, and had as much as they could consume; and the food was selected to represent, as nearly as the season permitted, the various sorts of food which hares and rabbits would live upon when running at large over a farm throughout the year. This experiment commenced on the 15th of March, 1845, and was continued for six weeks. The table on p. 92 is an exact copy of the table handed in to the Committee by Mr. Gayford, showing the precise results of the experiment. From this it will be seen that, in six weeks, twelve rabbits consumed—of oats, cut sainfoin, bran, carrots, and swede turnips—33 bus. 3 pk. 11 pt., weighing 68 st. 7 lb. 14 oz., and valued at 18*s.* 2¾*d.*; whilst during the same period two sheep consumed only 25 bus. 3 pk. 9 pt., weighing 45 st. 10 lb. 3 oz., and valued at 13*s.* 9¼d. The twelve rabbits thus exceeded the two sheep in consumption by 8 bus. of food, weighing nearly 23 st., valued at 4*s.* 5½*d.* *It follows from the above statement that, within a fraction, four and a half rabbits, during a period of six weeks, consumed as much food as one sheep.* Nor must it be forgotten that in this experiment, and in this estimate, no allowance is made for that which is destroyed and not eaten by hares and rabbits. Sheep can be fed, and are generally fed, on a particular spot, and they eat what is given to them, wasting little. With wild creatures the case is very different. Hares and rabbits, especially the former, run far over the fields; they cut pathways in the corn, and clear away large open spaces, as if to give themselves greater freedom in their gambols; and, in the abundance of food before them, they cut down and destroy, or greatly damage, much that they do not eat. It is the opinion of many well-informed farmers that the injury sustained in this way from hares and rabbits is equal to that which arises from their actual consumption of agricultural produce.

There is another very important branch of the subject. The question of game is one in which not the tenants only are interested. It is at least equally important in its effects on the condition of the farm labourers. 'A great head of game' presents on every side an amount of temptation which is hard to resist. A night of successful poaching is worth more in money than the wages of a week or a fortnight; and when so much is to be gained, there is little reluctance to violate the law, which, in the case before us, derives no strength and no sanctity from the respect and veneration of the people. The labourers do not regard game as property in the sense that sheep and fowls are property; they do not regard the taking of game as theft, and in these respects they are in harmony with the law itself. They are unable to discover any justice in the mode in which game is preserved, and to them the whole code of laws applicable

March 15, 1845.—Two Down Sheep, Housed and Fed against Twelve Tame Rabbits, supposed to be equal to Twelve Hares. The Sheep were a year old Each had all the food they would eat.

Sheep.

	Measure.	Description of food	Weight.	Price	Value
	bu. pk. pt		st. lb. oz		s d
Consumed by two sheep in a fortnight	0 1 9	Oats	0 12 8	1s. per st.	0 10¾
	4 0 0	Cut sainfoin	2 4 0	6d. per st.	1 1¾
	0 3 6	Bran	0 11 3	9d. per bus	0 7¾
	5 0 8	Carrots & swedes	13 12 12	6d. per bus.	2 6¾
	10 1 7		17 12 7		5 3

Rabbits.

	Measure.	Description of food.	Weight	Price.	Value.
	bu pk. pt.		st lb oz		s. d.
Consumed by twelve rabbits in a fortnight	0 1 11	Oats	0 13 8	1s. per st.	1 0
	4 1 8	Cut sainfoin	2 7 0	6d. per st.	1 3
	0 3 11	Bran	0 11 14	9d. per bus	0 8
	8 2 0	Carrots & swedes	24 4 0	6d. per bus.	4 3
	14 0 14		28 8 6		7 2

On the 29th of March each were weighed: Weight of sheep, 11 st. 8 lb.; and of rabbits, 5 st. 12 lb.

Sheep.

	Measure.	Description of food	Weight.	Price	Value
Consumption of second fortnight	0 2 4	Oats	1 4 0	1s. per st.	1 3¼
	2 3 0	Cut sainfoin	1 8 0	6d per st.	0 9¼
	3 3 8	Carrots	10 6 12	6d. per bus.	1 11¼
	7 0 12		18 4 12		4 0¼

Rabbits.

	Measure.	Description of food.	Weight	Price.	Value.
Consumption of second fortnight	0 2 12	Oats	1 8 0	1s per st.	1 6¼
	2 2 0	Cut sainfoin	1 6 0	6d. per st	0 8¼
	5 3 8	Carrots	15 13 4	6d. per bus.	2 11¼
	9 0 4		18 13 4		5 2¼

The falling off in consumption the last fortnight may in some measure be attributed to a change in the weather, it being much milder the last fortnight.

On the 11th of April each were again weighed: Weight of sheep, 11 st. 13½ lb; and of rabbits, 5 st 13¼ lb. Increased weight of sheep, 5½ lb; and of rabbits, 1¼ lb

The greater increase of weight gained by the sheep may, in some measure, be attributed to the rabbits being males and females, consequently they did not settle so well as the sheep.

Sheep.

	Measure.	Description of food	Weight.	Price	Value
Consumption of third fortnight	0 2 6	Oats	1 5 0	1s. per st	1 4½
	3 2 0	Cut sainfoin	2 0 0	6d. per st	1 0
	4 1 0	Carrots	11 2 0	6d. per bus	2 1½
	8 1 6		14 7 0		4 6

Rabbits.

	Measure.	Description of food.	Weight	Price.	Value.
Consumption of third fortnight	0 3 1	Oats	1 10 8	1s per st	1 9
	3 1 0	Cut sainfoin	1 12 0	6d. per st.	0 10
	6 2 8	Carrots	17 5 12	6d. per bus	3 3½
	10 2 9		21 0 4		5 10½

On the 26th of April each were again weighed: Weight of sheep, 12 st. 5 lb.; and of rabbits, 5 st. 9½ lb. Increased weight of sheep, third fortnight, 5½ lb; rabbits decreased in weight third fortnight, 3¾ lb.

The decreased weight of rabbits is accounted for from their having begun breeding.

Summary of the Consumption of Sheep and of Rabbits.

Sheep.

	Measure	Weight.	Value
	bus pk pt	st lb oz	s. d
First fortnight	10 1 7	17 12 7	5 3
Second fortnight	7 0 12	13 4 12	4 0¼
Third fortnight	8 1 6	14 7 0	4 6
	25 3 9	45 10 3	13 9¼

Rabbits.

	Measure	Weight	Value.
	bus pk pt	st lb oz.	s d.
First fortnight	14 0 14	28 8 6	7 2
Second fortnight	9 0 4	18 13 4	5 2¼
Third fortnight	10 2 9	21 0 4	5 10½
	33 3 11	68 7 14	18 2¾

to game seems but a contrivance of a powerful class to retain to itself certain modes of enjoyment, purchased at the expense of the weaker classes. They see the game of a great proprietor destroying the crops of an industrious occupier, and they feel that, to the farmer at least, their nocturnal expeditions are in no degree prejudicial. Whether it be right or wrong, it is a fact certain and admitted that the labouring classes generally consider our whole game code to be unjust and cruel. Magistrates, clergymen, chaplains of jails, and inspectors of prisons alike admit that labourers do not attach any idea of guilt or shame to infractions of the game laws, and that the poacher, when liberated from prison, is received among his fellow-labourers rather as the victim of cruel and partial legislation than as a criminal. So long as these feelings prevail, and we believe them to be ineradicable, there can be no hope that the presence of game will cease to be the source of much evil and demoralization to the peasantry. To the farmer, everything which makes the labourer less industrious, less honest, and less moral is an evil. If out of work, he is a burden on the poor-rate; and if in prison for offences against the game laws, the expenses of his prosecution, in many cases, and the cost of his subsistence in all, are defrayed from the county funds, to which farmers largely contribute, whilst the maintenance of his wife and family is thrown upon the poor-rate of the parish to which he belongs.

We have not alluded to other evils which spring from the gratification of the passion for game. Many of them are too notorious to require mention here. It may be remarked, however, that every winter the columns of the public journals are the records of desperate encounters between poachers and gamekeepers, wherein frightful wounds, and even death itself, are not unfrequently inflicted on one or more of those engaged in them.

It would be easy to enlarge upon the consequences which spring from that foolish and absorbing love of game which has so long possessed many of the proprietors of the soil in Great Britain. In discussions which have taken place, the advocates of game preserving have only succeeded in showing that their case is wholly without defence, and that there is no

justification for the harsh code by which it is upheld. They have said that landowners 'may do what they like with their own', forgetting that they have enacted special laws to enable them in many cases to inflict injuries on their neighbours and the public. They have asserted that, but for the pleasures of sporting and the battue, proprietors would not reside in the country, and the advantages of their presence would be lost to their tenants and the peasantry on their estates. This argument does not appear to have any real force. In counties or districts where game is not preserved, it is not found that proprietors are more absent than where game is abundant; and if it were so, we are unable to discover any advantages in a resident landlord that can compensate for the mischiefs of a 'great head of game'. A good resident landlord is a great blessing to a neighbourhood, for good men are valuable everywhere, and useful in proportion as their influence is great; but a landlord whose residence depends on his game, and whom no tie binds to his estate beyond that which arises from the indulgence of a sport which, at best, is more akin to barbarism than to civilization, is precisely one whose absence from any part of the country will not be deemed a local affliction. Whatever is gained in any locality by the expenditure of money in the preservation of game, or in the employment of men to drive the game within the range of the guns of modern sportsmen—or whatever advantages may arise from bringing together, for a few days in the season, a party of sportsmen of noble or gentle blood, with their servants, and horses, and dogs—we feel quite convinced that it affords no adequate compensation for the manifold evils which game preserving necessarily involves, and that whatever compensation is derived from it fails to reach the parties by whom these evils are chiefly borne.

The whole system of preserving game on cultivated lands is absurd and unnatural. Wild animals are intended only for countries uninhabited by man, or thinly peopled; and as population increases, and the soil is brought under cultivation, they gradually disappear. In this country the population is dense, and is every day pressing more and more against the means of subsistence; and at the base of our social system is a vast mass of poverty, much of which is created by the competition for employment, and the difficulty of procuring even a bare subsistence. At the same time, we have a great number of estates, some of moderate dimensions and others of enormous size, forming altogether no inconsiderable portion of this island, over which game is rigidly preserved, as though some great national interest were concerned in the breeding and rearing of wild animals. The conditions on which land is held by the occupying tenantry are thereby rendered most unfavourable for an improving cultivation; and we have deeply to regret, but cannot deny the fact, that agriculture with us is less advanced than are other arts and trades to which the skill and industry of our countrymen have been directed. The occupier or tenant of the land is harassed by a system which, had he not grown up with it, it is impossible he could so long have endured. The preservation of game involves other evils to the farmer besides loss of money. It destroys his self-respect and the independence of his character. He takes a farm and contracts to pay a rent; he stocks it with cattle and sheep; he ploughs, and sows, and reaps: *his landlord also stocks the same farm with hares, rabbits, and pheasants*, and enjoys his battue, or sends to market the game which his tenants' produce has fed. The tenant has his servants to superintend or conduct the operations on his farm, and to feed and protect his cattle and his flocks: *the landlord has his keepers to secure his game*; and these keepers are a spy upon the tenant himself, and traverse his fields by day and night, as though superior to his servants and himself. There are thus constituted to the same lands, and on the same property, two interests which must ever be diametrically opposed to each other—that of the cultivator, and that of the game preserver; and out of this, discord is sure to be engendered, and in thousands of cases failure and ruin to the weaker party.

In all this there is a fruitful source of degradation to the farmer. Men of capital and independent feeling will shun an occupation which involves so much of humiliation, or they will protest against a system so prejudicial to the country, and so destructive of the character of those who are subjected to it. We are sanguine that recent inquiries and discussions on this important subject will have the effect of inducing all persons connected with agriculture, whether as landowners or tenants, to assist in removing that which, we are convinced, is one of the most formidable evils which the cultivator of the soil has to contend with. When the tenant farmers make their wishes on this subject known to the legislature, we believe their interests will not be disregarded. But whilst we hope to see all legislative encouragement to the preservation of game abolished, we cannot but express our strong conviction that it is to the firmness and intelligence of the tenants themselves, as much as to any change in the law, that we must look for the abatement and final removal of this great and very prevalent obstacle to the prosperity of agriculture. [JOHN BRIGHT.]

Gang Ploughs. See PLOUGHS.

Gangrene.—By gangrene is meant death of tissues, followed by detachment from a line of demarcation which is often very clearly defined before separation begins. There are two principal forms of gangrene, the dry and the moist. Familiar examples of the former are the death of portions of young pigs' tails and of adult ears. The death of a quarter in a cow's udder, following on garget, is an example of moist gangrene with which readers may be familiar. Interference is to be deprecated beyond applying a disinfectant around the sloughing tissues. Healing is rapid when the slough has been cast. [H. L.]

Gangs, Agricultural.—In some districts of England it was customary for persons known

as gang-masters to hire children, young persons, and women, with a view to contracting with farmers for the performance of various kinds of agricultural work. In order to regulate such relations the Agricultural Gangs Act, 1876 (applicable only to England), was passed. The main provisions of the Act are as follows, viz.: A gang-master is defined as a person who hires a body of children, young persons, or women—known as an agricultural gang—with a view to their being employed in agricultural labour on lands not in the occupation of the person who hired them. No child under eight shall be employed in a gang. By the Elementary Education Acts no child under the age of eleven can be employed, nor any child under thirteen who has not obtained a certificate of having reached the standard of education fixed by law in force in the district in which he resides. No female shall be employed in the same gang with males, nor shall any female be employed in any gang under a male gang-master, unless a female licensed to act as gang-master is also present with the gang. The gang-master must be licensed by the justices, and no one who sells excisable liquors is eligible for a licence. The licence is granted for six months only, but is renewable. Offences against the Act are punishable by fine, and in addition the conviction is to be endorsed on the licence. If four convictions be registered against the gang-master, he is thereafter disqualified from holding a licence. [D. B.]

Gapes in Chickens. — What is commonly called gapes is a disease caused by the presence of a round worm (*Syngamus trachealis*) in the windpipe or bronchial tubes. The Gapeworm is also known under the names of Redworm and Forked worm. In colour, the female Gapeworm is red, and often reaches ¾ in. in length. The male worm is much smaller, and is nearly always found *in copulâ* with the female inside the host. The two thus make a fork, and hence the name—Forked worm. These worms attach themselves to the membrane by means of the 'sucker-mouth' with which they are provided, and when present in large numbers they block up the passage and cause the birds to gape in endeavouring to breathe. The disease is very common in several species, but poultry, young chickens, and turkeys are specially liable to attack, and at one time the mortality caused by the Gapeworm was very great. Some districts are more prone to the Gapeworm than others, especially where the ground is damp, and polluted water may be the means of spreading the parasite. It is seldom that it is met with on fresh-broken soil. When it is found that chickens are suffering from gapes they should be immediately removed to fresh ground, and especial care taken that the food and water vessels are clean, and water given pure and fresh. One plan recommended in Leaflet No. 58, issued by the Board of Agriculture, is as follows: 'Take the affected bird in one hand, and opening its beak with the thumb and finger, place in its mouth a piece of camphor about the size of a small pea, then close and hold its beak for a moment to compel the bird to swallow the morsel, and the operation is complete'. A simpler remedy is the use of Chamberlain & Smith's Kaylde, a volatile powder, which, blown into a coop or box in which the chickens are placed, causes the worms to loose their hold, and the birds can thus cough them up. Care must be taken to burn the expectorated worms so as to avoid further infection. [E. B.]

Garbage. See NITROGENOUS ORGANIC MANURES.

Garden.—A garden may be described as an enclosure in which plants of various kinds are cultivated for use and ornament; the term is also applied to enclosures which are not really devoted to horticulture. Thus we have tea gardens, zoological gardens, and pleasure gardens. Horticulturally considered, the garden may form part of the conveniences of a residence, or it may be used solely for commercial purposes, as are market and nursery gardens, or it may be a place of common resort, or again it may be specially designed for educational purposes. A kitchen garden is one in which food plants generally are cultivated; a flower garden is devoted exclusively to the cultivation of flowers and plants for ornament; a rock garden is designed specially for the accommodation of plants from alpine regions; a winter garden is a large glass structure in which the conditions are favourable for the growth and protection of plants during the winter season. No doubt the garden had its origin in the desire of men to have near their dwellings the plants that were useful as food. Evidences of this are to be seen now among the most savage of tribes, the planting of a few bananas, cocoanuts, breadfruit, &c., close to their dwellings being an example of gardening in its most primitive form. All civilized nations, ancient as well as modern, have included gardening among the arts. Gardening was practised among eastern nations as early as B.C. 1500-1200, or earlier. The Egyptians, Babylonians, Jews, Persians, Greeks, and Romans had sacred groves or gardens, often of extraordinary beauty, in which trees were planted for effect, and flowers were grown with very much the same object as that for which they are cultivated to-day. They also appear to have understood the art of the improvement of plants by selection. According to Loudon, upon the outside of the pyramid of Cheops was found an inscription in Egyptian characters showing that radishes, onions, and garlic were cultivated vegetables at the time of its erection. The Persian gardens of 500 B.C. were planned for effect, the trees being planted in squares and avenues, with roses, &c., intermixed. The Persian King Cyrus is said to have displayed a passion for gardening, and wherever he resided or visited he took care 'that the garden (paradise) should be filled with everything beautiful and useful that the soil could produce'. There were gardens in ancient Rome which abounded with flowers such as lilies, roses, and poppies planted in beds. Plutarch speaks of terraced gardens, and it is said that a taste for the natural as distinguished from the formal style of garden prevailed even in his time. The famous Italian gardens are no doubt relics of that period. The art of gardening in Great Britain owes its ori-

gin to the Romans, but its development may be said to be more complete in England than in any other country in the world. English gardens have a character of their own, and what is known as the English style is a happy mixture of formality in design with the informal or natural.

Commercial gardening in this country now is of great importance, horticulture being a highly developed industry, employing many thousands of persons, whilst millions of money are invested in it. Nursery gardens in particular occupy an important position. They not only keep up a supply of all kinds of plants to be used in every section of the garden, but they are also the emporiums for new introductions from other lands, or new developments by the breeder; hybridizing, crossbreeding, and selection, as well as experimental cultures of all kinds, being conducted in many nursery gardens in this country. The commercial spirit is now a great force in British horticulture, entering largely into the work of the amateur, many large private gardens, formerly kept up for pleasure alone, being now run as commercial concerns and made to pay. There are also many gardens in this country which are used as centres of instruction. The great botanic gardens serve a double purpose, in that they are places of resort for pleasure, and also are object lessons in the art of making and keeping a garden. School gardens have lately been developed in the interests of those young people who may be expected to become more or less concerned in the cultivation of the soil. The county councils have established experimental and teaching gardens in districts where they are likely to influence owners of gardens in the adoption of the best methods of cultivation and the most suitable plants to grow. See next two articles.

The produce of a garden may be rich or poor according to the conditions with respect to soil, climate, and also according to the ability with which it is cultivated. The best skill devoted to horticulture will obtain results many times greater than those produced by farming even of the most advanced type. [W. W.]

Garden, Cottage.—One of the deepest and most pleasant impressions carried away by foreigners who see much of this country is that created by the cottage gardens. Indeed, in many districts horticulture is so assiduously practised, and so well understood by the rural population, that it would be almost an impertinence to advise. Certainly there can be no two opinions as to the value of a well-kept garden to the cottager; having a piece of land which he can cultivate is one of the most considerable of the advantages which the country workman possesses over the city dweller, and there is now a movement to benefit the less fortunate townsfolk by the loaning to them of vacant land near towns. Of late years the county councils have devoted a good deal of attention to the popularizing and improvement of horticulture by the appointment of instructors, teaching of gardening in schools, and by other means; this is a useful work, but obviously the greatest efforts should be directed to where (as in parts of Ireland) gardening is but little understood. Cottage gardening is commonly liberally encouraged by the more beneficent owners of large estates. It is an excellent and mutually helpful plan to establish an estate nursery, more particularly for the raising of fruit trees and bushes, cabbage and tomato plants, &c., for distribution, and to employ a skilled gardener, whose special duty it is to encourage horticulture among the cottagers by the giving of assistance and advice. Prizes are sometimes offered, and this has a wonderfully stimulative effect, but the local flower show quite commonly provides this form of inducement without such direct outside aid.

The cottager is not, as a rule, fortunate in the varieties of fruit that he plants for a home supply. He does not perhaps realize the fact that the difference in quality and productiveness between the many varieties in cultivation is very considerable, and that the best are as easily managed as the worst. Failing a cheap supply from the estate nursery, he should go to the best nurseryman in his district to ensure healthy young trees on the most suitable stocks, and true to name. Seeing that the best fruits are excellent food, that some of them keep almost as well as potatoes, and that they are always saleable, the cottager should not hesitate to replace inferior kinds with the best. On p. 96 is a selection of the different sorts of fruit suitable for a cottage garden.

Fruit trees and bushes should be planted in October, pruned in November, and manured in spring. They require watering in dry weather. Strawberries should be planted in July or August if the runners are ready. After the third year the beds should be renewed. Firm planting is in every case necessary.

Generally speaking, cottagers might advantageously devote more attention to fruit growing. Even on a modest scale, this is undoubtedly profitable when assiduously and intelligently practised. It is not generally understood in this country how successfully an undercrop may be combined with fruit trees. In Normandy the small orchards commonly have corn and other crops flourishing beneath the trees.

Vegetable seeds of the best strains are now very cheap, and the cottager's vegetable garden may be so managed as to supply good food for all times of the year. He can grow and store sufficient potatoes for the year; keep up a regular supply of cabbage, brussels sprouts, cauliflowers, and coleworts; onions, best of food and medicine, are easily grown and kept; leeks for broth; broad, French, and kidney beans, peas, vegetable marrow, rhubarb; celery, carrots, turnips, parsnips, beetroot, lettuce, radishes, and the various herbs, such as sage, mint, thyme, and parsley. These are all necessary to the well-stocked cottage garden, and that they are easily cultivated is fully demonstrated by the men who are acquainted with the art of working the soil. Even tomatoes, seakale, and asparagus are not beyond the cottager's means. Where frames are available and straw manure can be obtained, a hotbed for forcing salad plants in winter would be

Apples for Cooking

Name.	Time when ripe.	Quality.
Beauty of Bath.	August.	First-rate early sort.
Potts' Seedling.	August to September.	Large, a hardy free sort.
Ecklinville.	September to October.	Superior to the old Keswick.
Blenheim Orange.	November to February.	A good all-round sort.
Lane's Prince Albert.	November to April.	A great cropper and good keeper.
Bramley's Seedling.	December to April.	The best if only one is needed.

Apples for Dessert

Irish Peach.	August.	Ripens quickly, a poor keeper.
Worcester Pearmain.	September.	Handsome, and good in flavour.
King of the Pippins.	October to January.	Best in a sheltered situation.
Cox's Orange.	November to March.	The best apple.
Allington Pippin.	November to March.	Larger than Cox's.
Sturmer Pippin.	February to June.	The best late sort.

Pears for Cooking

Vicar of Wakefield, Catillac, Verulam.

Pears for Dessert

Williams' Bon Chrétien	September.	The best early sort.
Louise Bonne of Jersey	October.	Delicious flavour.
Doyenne du Comice.	November.	The best all-round pear.
Marie Louise.	October to November.	Prefers a wall.
Josephine de Malines.	January to March.	A good keeper.

Plums

Cooking: Early Prolific, Victoria, Monarch.
Eating: Early Transparent, Jefferson, Coe's Golden Drop.

Damsons

Farleigh Prolific, Bradley's King.

Cherries

Cooking: Kentish, Morello.
Eating: May Duke, Kent Bigarreau, Early Rivers.

Raspberries

Carter's Prolific, White Antwerp.

Currants

Red Dutch, White Dutch, Lee's Prolific (Black).

Gooseberries

Red: Crown Bob, Champagne, Warrington.
White: Pitmaston Greengage, Whitesmith.
Green: Whinham's Industry, Stockwell, Keepsake.

Strawberries

Royal Sovereign, President, The Laxton.

found profitable. Early potatoes may be grown in a sheltered corner, and if a peck of Early Ashleaf is put into the ground in the first week in February, they will, with luck, be ready to lift in the first week in May, when new home-grown potatoes are a great treat. A little resourcefulness goes a long way in the garden.

The cottage garden is usually floral in front of the house and utilitarian at the back. It should contain no hungry worthless trees or shrubs, which impoverish the ground and occupy space where fruit trees or bushes would thrive and be profitable. Shelter is provided by a fence—if of holly, hawthorn, or beech so much the better; but the fence must be kept trimmed and in order, so as to serve the double purpose of keeping out animals, &c., and protection from cold winds. The absence of design is perhaps the great charm of the English cottage garden. There are paths only where they serve a useful purpose; the porch serves as a support to a rose or other climber, the house is beautified by clematis, honeysuckle, or other creeper, and the borders are filled with a variety of flowers placed with little regard to arrangement yet producing a pleasing and usually harmonious effect. Sweet peas are cottagers' favourites, so also are the pansies and violas, and the Shirley and other poppies. A selection of the best of the cottage garden flowers would include the following: Roses, rhododendrons, flowering currants, forsythias, daphnes, honeysuckles, clematis, lilac, syringa, carnations, hollyhocks, wallflowers, polyanthus, daffodils, sweet peas, sweet williams, auriculas, delphiniums, lupins, aquilegias, aconites, fuchsias, dahlias, verbenas, chrysanthemums, godetias, stocks, asters, tulips, crocuses, snowdrops, anemones, Canterbury bells and other campanulas, candytuft, irises, lilies, Michaelmas daisies, phloxes, pyrethrums, crown imperials, pæonies, hellebores, evening primroses, day lilies, gaillardias, honesty, pentstemons, snapdragons, sunflowers, rosemary, and lavender. In these days of cheap seeds the cottager might make many additions to the plants he grows for their flowers; there are also the newer roses, particularly the hybrid teas, of which Caroline Testout, Augustine Guinoisseau, Gustav Regis, and Madame Chatenay are beautiful representatives. Carnations also have been enormously improved as border plants. [w. w.]

Garden, School.—The number of school gardens in rural districts is rapidly increasing, and already there are upwards of 2000 established throughout England. Gardening as a subject in elementary schools has much to commend it, for it provides physical exercise, as instanced, say, in the correct handling of tools, in addition to offering exceptional opportunities for developing latent powers of observation, and that capacity to combine practice with theory which is too often lacking in the products of present-day educational institutions.

Soil.—It is not always possible to select an ideal site, or a uniformly fertile soil on which to establish a school garden, nor is it essential

to obtain these exact conditions, inasmuch as the object in view is a purely educational one. While no soil of average quality need be neglected, it is nevertheless well to avoid heavy tenacious clay soils and those of a loose sandy nature.

ARRANGEMENT.—Several systems are adopted in working a school garden, the most popular of which is to assign one square rod of ground to each scholar. This system of separate plots has the advantage of developing the individuality of the worker. Some schools favour a dual plot, having an area of two square rods and worked jointly by two scholars, a second-year boy acting as senior and a first-year boy as junior.

A common plot cropped much on the same plan as an allotment or cottage garden may also serve the purpose of a school garden, the pupils working together under the supervision of the instructor. Although affording an opportunity for the cultivation of a larger variety of plants, this system has the disadvantage of concealing individuality, the more willing and enthusiastic worker doing more than his legitimate share of labour.

The school garden of the future will probably combine both the common and the individual plot system, so that when each scholar has been entrusted with the care of a separate plot he may in the third year unite with others in the management of the common plot, and in the performance of any operations requiring special care.

Instead of the common plot being limited to the cultivation of vegetables and flowers, there is no reason why it should not contain a suitable selection of hardy fruits, for the growth of which our soil and climate are so well suited.

SITE AND PLAN.—Scholars should take an active part in the planning of the garden, first drawing the plan to scale on paper, and afterwards pegging out the actual measurements for the ground. Naturally drained land with a slope towards the south or south-west is to be preferred, the rows running due north and south. All plots should be rectangular in outline, and the drills containing each crop arranged to form continuous lines throughout the whole extent of the ground; thus when viewed at a distance the garden gives the appearance of one large area divided into rows, each of which represents some distinct plant. When enclosing new ground it must be suitably fenced before hedge planting is proceeded with, and unless the soil is already under good cultivation it will be advisable to manure and trench according to requirements.

The average width for pathways need not exceed 1½ ft., and these may consist of the original turf, or be composed of gravel with some simple form of edging.

For the raising of seedlings requiring to be transplanted it will be necessary to have a reserve border, and where fruit plots are established similar accommodation will be required for the propagation of fruit trees.

EQUIPMENT.—When selecting vegetables, typical varieties should have preference to what are familiarly known as novelties. Where girls are offered facilities to learn gardening, their attention should be directed to the cultivation of flowers, whereby they may become familiar with the habits and cultivation of those most adapted to the decoration of the home. When selecting flowers their botanical and general characteristics should be as variable as possible, thereby affording ample material for classroom instruction. Collections of vegetable and flower seeds, to meet the requirements of school gardens, can be obtained at a reasonable cost from leading seedsmen. Special sets of garden tools are also manufactured expressly for school-garden work, it having been found advisable to provide the youthful beginner with somewhat lighter implements than are used by adults, yet possessing the same standard of quality and usefulness. A convenient store or tool shed must be attached to every garden, and strict attention must be given to the care of all the implements used.

MANAGEMENT.—Provided he has an elementary knowledge of the science and practice of horticulture, the head teacher is best adapted to impart instruction and maintain discipline. Periodical visits from the county instructor or specialist in horticulture will be valuable in keeping the teacher posted with new and improved methods of cultivation; also an inspection and report of the plots will give stimulus to all concerned in their welfare.

COMPETITION.—Much may be said for and against competition, whether confined to individual schools, or where a number of schools compete one against the other. The object of such competitions must not consist in the production of exhibition produce, but should be based on the general good work accomplished throughout the year.

MARKETING PRODUCE.—The marketing of produce will depend entirely on local conditions. Where a common plot is established it is customary to market the whole of the produce, the receipts for which go towards the expenditure on implements, manures, and seeds; a detailed statement of expenditure and receipts being kept by each boy.

EXPERIMENTAL WORK.—There is no reason why simple cropping, manurial trials, or experiments should not be introduced into school gardens; observations concerning these being noted in the garden diary, which it is compulsory for each scholar to keep.

Every school garden should be provided with the simpler meteorological instruments for recording weather observations, and special attention should be devoted to the study of bird and insect life; while the most successful means whereby to combat the numerous insect and fungoid diseases peculiar to the district must be intimately dealt with. [J. C. N.]

Gardener, Training and Qualifications of a.—Horticulture in the British Isles occupies a position second only in importance to agriculture. The census of 1901 revealed that there are about 250,000 persons employed in its several departments in this country alone. For centuries horticultural art

has steadily advanced, and we have now societies concerned with gardening in most towns of importance, the Royal Horticultural Society alone, with a teaching garden at Wisley, and an exhibition hall at Westminster, consisting of about 10,000 members. Horticulture, while being associated with agriculture and botany, occupies a distinct field of its own. It is concerned with such subjects as the influence upon plants of temperatures, light, soils and manures, water, air, and drainage; such operations as grafting, budding, layering, cuttings, seed sowing, pruning, transplanting, forcing, retarding, and storing; improvement of plants by breeding and selection; the diseases and pests of plants; the formation of gardens, and the production on commercial lines of the manifold parts of plants which are used economically by man. From this it will be seen that a well-equipped professional gardener must go through a course of training of a very varied character. Knowledge by itself is not sufficient; he must acquire skill from actual practice, and considerable experience before he can perform or control the many and varied operations that gardening entails. This training he gets as a rule by working in gardens from boyhood onwards. To qualify as a professional gardener, a boy say of fourteen or fifteen begins work as an apprentice or garden help. In five or six years he will be fit for the position of journeyman, working under the supervision of more experienced gardeners. From this his progress will be towards the position of head gardener or manager. The practical side he learns in the working hours of a generally long day, while the theory and bookish side he picks up according to circumstances. Gardening therefore is learnt similarly to the ordinary trades, such as carpentry, bricklaying, &c.

There are at present only few recognized schools or training colleges for high-class professional horticulture. It is doubtful, indeed, if such are of much value in affording that training which enables men to become skilful, practical gardeners of the calibre that are developed by the usual methods. Generally, the professional gardener is a development from the country lad, who on leaving school finds occupation as a garden boy, and owing to circumstances over which he has little control finally emerges as a professional workman.

Wages in horticulture are below the standard of wages in this country for skilled workmen generally, while the hours of labour are, on the whole, excessive. As a result, horticulture as a means of livelihood fails to attract the most intelligent lads; fortunately, however, many of those who by force of circumstances become professional gardeners are men of the best type, and the position occupied by British gardeners throughout the world is quite worthy of the race. Commercial horticulture offers more opportunities owing to the extent of the trade in plants and garden produce of all kinds, and the best of all training schools for the young gardener is the well-managed nursery or market garden, of which there has been an enormous increase during the last twenty-five years. Not only is the art of cultivation practised on the most advanced and at the same time economical lines, but business habits are also learnt in such establishments.

As matters stand at present, the best training for a gardener is to work until he is twenty-one in a private garden, then for two years in a good nursery or market garden, and if after this he can devote a year or two to studying horticulture in such establishments as the botanic gardens of Kew, Edinburgh, or Glasnevin, he will by that time have laid the foundation of a competent knowledge and skill in horticulture.

[W. W.]

Gardeners' Garters, an ornamental grass with variegated striped leaves. See PHRAGMITES.

Gardening, Landscape.—This has been described as an art which succeeds, by careful study of natural effects in landscape, *i.e.* aspect, in reproducing their best in an artificial way. The term is, however, generally understood to mean the planning or designing of garden effects, whether they be on natural lines, or in the formal and artificial style affected by a certain school of garden makers. In the United States the term 'landscape architect' is used to denote the maker or designer of a garden. A garden may be made to satisfy any fancy, just as any other work of art may be the realization of an idea, and while it may not appeal to one man's sense of what is fitting, to another it affords satisfaction. Correctness of taste in landscape gardening therefore means conformity to the prevailing fashion, which in one country may be formal and extremely artificial, while in another it is as close an imitation of nature as is possible in a garden meant for use and enjoyment.

The formal lines on which the early gardens were planned no doubt were the outcome of the original purpose for which a garden was intended, this being essentially utility. A square plot was surrounded by a high wall, inside which borders and paths were made for convenience solely; such gardens the early monks made. As the garden grew in extent and diversity it still kept to these lines, and just as fruit trees would be planted in straight lines, so trees planted for decoration were set out on the same plan. By men of cultivated taste this came to be looked upon as inartistic; and when it grew to a mutilation of plants to make them resemble other objects, and gardens became more or less a confusion of bushes cut into the most ridiculous shapes, hedges made to resemble battlements, and flowers stuck into the ground to represent some particular design, the absurdity of it all became evident. Addison, writing in *The Spectator* in 1712, said: 'Our British gardens instead of humouring nature love to deviate from it as far as possible. Our trees rise in globes, cones, and pyramids. We see the marks of the scissors upon every plant and bush. I do not know whether I am singular in my opinion, but for my own part, I would rather look upon a tree in all its luxuriance and diffusion of boughs and branches, than when it is thus cut and trimmed into a mathematical figure; I cannot but fancy that an orchard in

flower looks infinitely more delightful than all the little labyrinths of a most finished parterre.' His contemporary Pope gave an amusing list of sculptured trees: Adam and Eve in yew; Eve and the serpent; St George in box, with a green dragon, its tail formed of ground ivy; divers eminent modern poets in bay; a quickset hog, &c. He laughed to scorn that taste which preferred to see trees and bushes in the most awkward figures of men and animals instead of their own natural forms. Out of this ridicule grew the movement which resulted in gardens formed on more natural lines. The plants were allowed the full expression of their own beauty, and they were grouped as nature groups them, while lawns, paths, flower beds, and borders were all designed so that the general effect was as natural as circumstances would permit. The use of water for effect was also recognized, lake, pond, and stream being formed in such a manner as to appear to be nature's work. This style of garden design came to be known as English landscape gardening. It has been copied more or less in other countries, and notwithstanding recent efforts to revive the taste for the formal garden which Pope and Addison ridiculed, the natural arrangement is generally preferred.

It is said that the characteristic genius of English gardening received an impulse from the recognition of the natural beauties of our country, which offers a great variety of types of landscape effect. The true landscape gardener 'takes the lessons of nature in her most beautiful aspects of vegetation—as to breadth, airy spaces, massing and grouping of the woods that fringe the valleys or garland the mountain rocks—as better beyond all that words can express than anything men can invent or ever have invented. We prefer the divinely settled form of the tree or shrub or flower beyond any possible expression of man's misguided efforts with shears' (W. Robinson). At the same time the fact must not be overlooked that a garden to be enjoyed must be so arranged with regard to paths, well-kept lawns, and flower beds that it can be visited and enjoyed at any time of year and in any kind of weather. For this reason we have come to look upon certain artificial features of the well-designed garden as essential. The best-formed gardens are those which combine a pleasing general effect with interesting detail, in exact opposition to say the long straight avenue of trees, and the mathematical arrangement of flowers which are used only to form a design, and not for their own intrinsic merit and interest. A garden should be, to some extent at least, a place in which various kinds of plants are grown for use, or for their attractiveness and interest.

Landscape art does not enter into designs for kitchen gardens, although the garden designer is expected to plan this part of the garden with a view to its convenience, and also to its non-obtrusion on the more picturesque parts. To break down the fence and make all nature a garden is the ideal; fences, of course, must be used, but the limitations they express can often be disguised. The suggestion of space and distance is as important as that of seclusion and safety. Vistas and distant views where obtainable are worth striving for. The nature of the surroundings will, as a rule, decide the character of the garden. In the country, opening up is often easy of accomplishment, whereas in the neighbourhood of towns there are, as a rule, many objects which it is desirable to keep out of the view. The flower garden should be placed near the house, but it need not be a part of the scheme unless it harmonizes with the rest. Variety is of course essential, and a flower garden need not necessarily be formal, while the material used for filling it, if carefully chosen, will prevent any colour discord. The design of the garden should be appropriate to the principal building, and the selection of the trees to be planted near to buildings of any kind should be carefully done. While gardens should in principle be of the correct English style, they need not be alike; on the contrary, every one might differ from its neighbour and yet be beautiful. The best effects are those obtained by allowing all the plants to assume a natural habit. It is to degrade plants when they are mutilated and made to look like something else. [W. W.]

Gardening, Market. See MARKET GARDENING.

Gardening for Women.—Everybody knows, in private life, women who have been highly successful gardeners. Women have also distinguished themselves as botanists. Such a work as Miss Jekyll's Colour in the Flower Garden, and the advertisements in the amateur gardening press offering plants and seeds for sale, show that some women are successful in gardening on commercial lines. It was natural, therefore, that there should have been an attempt to find an opening for young women of education as professional gardeners. Some years ago the Countess of Warwick established at Reading a hostel for girl students of horticulture. Later on, this enterprise was transferred to Studley Castle, near Studley, Warwickshire. There is also a ladies' horticultural college at Swanley, Kent. More recent ventures are the establishment at Bredon's Norton, and the enterprise at Glynde in Sussex, for which the Hon. Frances Wolseley, author of Gardening for Women, is responsible. There are also facilities for girls learning gardening at Edinburgh and in London. Tuition, board, and lodging during terms such as are observed at schools cost about £80 a year at Studley and Swanley. For bedroom instead of cubicle accommodation the charge is about £120: there are also some small expenses. The scheme of training is drawn up for two- and three-year courses. Among the subjects taught, in addition to gardening—fruit, vegetables and flowers, indoor and out—are dairy work, poultry keeping, fruit preserving, beekeeping, bookkeeping, and carpentry. The movement has had, of course, largely to train its own teachers. There are four classes of girls seeking instruction: first, those who desire to get their own living armed with the certificates of their college; second, those who seek to better their health; third, those who are owners of property, the dairy

farming, horticulture, &c., of which they desire to improve; fourth, those who are going to the colonies. Swanley has a special colonial section. It is stated that of the 145 students who passed through the Reading Hostel or Studley College (which confines itself to the daughters of professional men) during the first seven years' operations, 28 possess a small holding or market garden, 12 are working in home gardens or on home farms, 20 are in posts in England, 4 in posts in the colonies, 6 were placed on the staff, and the remaining 104 were short-course or colonial-course students, who 'are not considered as permanent workers'. It is obvious that some of the girls who go to the colleges lack the ability and character to make their own livelihood, and that the others, in the present highly developed condition of the market-gardening trades, must have hard work to push their way. It will be seen that college training costs not far short of £300, and the students at the end of their course are only qualified to go as improvers. On the other hand, the outlay of such a sum on a boy's training for a career is not grudged. There are undoubtedly openings for girl gardeners in the wholesome and attractive work of private gardens, and the gardens of institutions, and as county council lecturers. Girls, too, of exceptional qualities, with a proper recognition of their imperfect training, and possessed of ample capital, succeed from time to time on their own account; but intending students and parents would do well to make careful enquiries before deciding that girls whose only qualification is their liking for the country and distaste for indoor life will be able to make their living in the highly skilled industry which supplies Covent Garden and the equally difficult markets of our provincial cities.

['H. C.']

Garden Warbler (*Sylvia hortensis*).—This bird is closely related to the Blackcap (which see) in general appearance and habits, but is not so conspicuous, being dull-brown and white in colour, with bluish legs. It is fairly common in south-east England, but rare in most parts of Wales, Scotland, and Ireland, while Cornwall is practically beyond its range. Garden Warblers are summer visitors, usually arriving in early May and remaining with us for five months. The nest and eggs closely resemble those of the Blackcap, but are a good deal larger. So far as agriculture pure and simple is concerned the species is beneficial, but its fondness for fruit (especially cherries) makes it an enemy of the gardener and fruit grower, who are fully justified in keeping down its numbers.

[J. R. A. D.]

Garget, Mammitis, Inflammation of the Udder.—Much loss is sustained by dairy farmers by inflamed udders; nor is it confined to cows—mares injuring their foals when suffering from this malady, ewes starving their lambs, and sows turning upon their young and destroying them. Simple mastitis or inflamed lacteal glands may result from chills on the cold ground or draughts in the byre; but a large proportion of the cases met with are infectious, and conveyed from cow to cow by the hand of the milker. In a large dairy, where this malady is once introduced, cases keep cropping up, but infection is rarely suspected. The symptoms are generally known, and consist in a hard swelling of the bag, difficulty in obtaining milk, suspended rumination, loss of appetite, and the highest readings of the thermometer obtained in any disease known in cattle, as much as 111° F. having been observed. If early treatment is unsuccessful, an abscess is liable to form in the udder and lead to the loss of the quarter, or the whole quarter may become gangrenous (see GANGRENE), a line of leaden blue marking the division between the living and dying tissues. A great mass presently falls out and leaves a cavernous wound, which, however, soon heals. A more frequent sequel is a conversion to fibrous tissue in part, with enough true gland left to spring again at the next calving, and bring about another garget or inflammation. In apparently cured cases, a focus of future trouble is often left, the small hard body being awakened at the time of parturition, and liberating elements which again cause the disease, or obstructing the channel and setting up inflammatory action by reason of retention of the milk. Enough has been said to show the serious nature of a merely 'hard bag', and to point to the necessity of prompt attention. A strong purgative, containing from 1 to 3 oz. of aloes, with 1 oz. of ginger, and ½ to 1 lb. of salts, should be given; the udder should be massaged with camphorated oil, not irritated by ammonia liniments, as is too often the practice, and gentle but frequent efforts made to keep open the channel by operating the teat. A sterilized milk syphon is helpful, and should be withdrawn and cleared as often as it is blocked by the little clots which are found in a discharge, always varying from watery to thick matter. The infectious garget is best treated by injections into the quarters, passing the instrument up the teats and syringing with a 1-per-cent lysol or chinosol solution, to which 3 per cent of glycerine is a soothing addition. The greater number and smaller calibre of the ducts in other species do not permit of this treatment, and reliance must be placed on fomentations and massage with suitable remedies, and an aperient appropriate to the species, age, and breed of the animal.

[H. L.]

Garlic (Allium).—This genus of bulbous liliaceous plants, which comprehends garlic, onion, chive, and shallot, also includes two troublesome weeds with which land is sometimes infested. Their peculiar oniony odour renders it impossible to mistake them for other plants.

WILD GARLIC (*A. ursinum*), also called ramsons or broad-leaved garlic, has a slender white bulb, from which proceed one or two broad, flat, bright-green parallel-veined leaves. The flowering stem or *scape* rises immediately from the centre of the leaves, and ends in an umbel of twelve snow-white six-parted flowers. This plant is found occasionally in pastures, but commonly in hedgerows, woods, thickets, and similar places. All the parts — bulbs, leaves, and flowers—emit a most intense odour of garlic,

which is readily communicated as a taint to the milk, butter, and cheese obtained from cows that feed upon it. Pastures in which it occurs are entirely unsuited to these animals until after midsummer, when the leaves lie down; the mischief disappears till the return of spring.

The bulbs of the plant are so tenacious of life that they cannot be effectually destroyed by removal, for every scale that remains in the ground may propagate and produce a new plant. In the absence of fallowing and careful tillage, the only course is to hand-pick the land as soon as the leaves begin to appear in the spring, and to persevere incessantly till the season of growth is over. By this means the bulbs become so weakened that they can barely live, and propagation ceases. A second spring will doubtless produce a new brood of weak plants; but if the hand-picking is again begun early and practised diligently, the race must become extinct.

Crow Garlic (*A. vineale*) is readily distinguished by having a leafy air stem about 2 ft. high, and a round close head of small pale rose-coloured flowers, among which are found many little bulbs instead of flowers. This is a perennial species which propagates rapidly in dry pastures and cornfields. Its bulbs are small, clustered, and not deep rooted; and its smell is less offensive than that of ramsons. In consequence of its having an elongated leafy stem it is easily distinguished from the vegetation with which it is mixed, and may be easily pulled up. Its innumerable bulbs are, however, so difficult to get out of the ground that it can only be effectually dealt with in the manner described under the last species.

We have, moreover, the comparatively rare *Allium oleraceum* (Field Garlic), with leafy stems like the last species. It has, however, simple bulbs, a loose cluster of flowers, and none of the stamens are stipulate. [J. L.] [A. N. M'A.]

Garlic, Cultivated (*Allium sativum*), a native of southern Europe, is now grown in most countries for its bulbs, which have a powerful burning taste and peculiar odour. They are used for flavouring. The bulb is composed of about a dozen sections, called cloves, really a number of small bulbs enclosed in a membranous bag. The cultivation of garlic is not much practised in the British Islands, the milder-flavoured onion being preferred. In France and Italy garlic is largely grown, the cloves being planted in October as we plant shallots, in deep well-drained soil, and they are ready for use by the following June. [W. W.]

Garlic Mustard, a cruciferous weed which emits a strong smell of garlic. See Sisymbrium.

Garner, a granary or storehouse for grain; also a bin in a mill.

Garrya, a genus of hardy evergreen diœcious shrubs (nat. ord. Cornaceæ), natives of California and Mexico, one species being found in the West Indies. *G. elliptica*, introduced in 1818, is the most useful and noteworthy of the half-dozen species cultivated in English gardens, the long yellowish-green catkins of the male plants being very decorative during the winter months. It is unfortunately not perfectly hardy except in the warmer parts of the British Islands, and in the colder districts should be afforded the protection of a wall. It is propagated by seeds, or by cuttings of half-ripened wood inserted in August. [W. W.]

Gas and Gas Plants.—Coal Gas.—The ordinary gas used in cities and towns for illuminating purposes, &c., is obtained by the destructive distillation of bituminous coal in closed retorts made of fireclay, or, less frequently, of cast iron. The retorts, in cross section, are of various forms—oval, round, and ⌂-shaped—and, when made of fireclay, are commonly 2½ to 3 in. thick, 16 to 22 in. wide, 13 to 16 in. high, and 9 to 10 ft. long. They are arranged in groups of seven or nine, in retort houses, each group being heated by a separate furnace which consumes either coke or gaseous fuel derived therefrom. One end of each retort is closed, and to the other end is attached an iron cap having—(1) a socket, into which the lower end of a vertical pipe, called an 'ascension' pipe, is fitted, and (2) a door, through which the retort is charged and the carbonaceous residue—coke—withdrawn. The 'charge' of coal varies from 2 to 3 cwt. for each retort, and the time required to effect the expulsion of the volatile matters or crude gas varies from four to six hours. The 'ascension' pipes are bent over at the top, and dip into ammonia liquor contained in a long iron box, called the hydraulic main. As the crude gas is generated it passes up the ascension pipes into the hydraulic main, and then through a series of cooling pipes, in which it deposits a large quantity of tar and ammonia products. It then passes through towers, called scrubbers, which are filled with coke moistened with ammonia-water spray and which absorbs some of the sulphuretted hydrogen (H_2S) and carbon disulphide (CS_2) contained in the crude gas. The remainder of the impurities, and any carbonic acid (CO_2) which the gas contains, are then removed by passing the gas over layers of slaked lime, or of slaked lime and iron sulphate mixed, finely divided and made porous by sawdust. The purified gas thus obtained is variously called coal gas, town gas, or illuminating gas, and is collected into a gasholder, where it is stored and issued as required.

The quality and quantity of gas formed varies considerably with the nature and composition of the coal used, as well as with the temperature at which the distillation takes place and the time it is allowed to continue.

The illuminating value of coal gas, as tested by a standard burner consuming 5 cu. ft. per hour, varies from less than 15 candles in some cases to over 25 candles in others, and the yield of purified gas per ton of coal varies from 6500 to 15,000 cu. ft.

In addition to the gas, various valuable by-products are obtained by the distillation of coal in retorts. For example, for every 100 parts by weight of average bituminous coal treated, the yield is from 64 to 65 of coke, 14 to 16 of purified coal gas, 10 to 12 of ammonia liquor, and 6·5 to 7·5 of tar.

The composition of coal gas varies consider-

ably, as will be seen from the following table, which gives in fractions of a cubic foot the volumes of the constituent gases contained in a cubic foot of the coal gas:—

	Hydrogen, H.	Carbonic Oxide, CO.	Methane, CH_4.	Heavy Hydrocarbons, C_2H_4, &c.	Carbonic Acid, Nitrogen, &c.
One cubic foot of—					
Average coal gas ...	·47	·09	·34	·05	·05
London „ ...	·506	·039	·37	·055	·054
Glasgow „ ...	·392	·071	·403	·100	·034
Liverpool „ ...	·364	·034	·443	·079	·080

The heating value of a coal gas can be readily calculated from its analysis (see FUELS).

As different gases have different compositions, as shown in the above table, they will have different heating values. Per cubic foot, the heating value of coal gas varies from about 620 to 800 F. heat units. Further, on an average, 10,000 cu. ft. of coal gas is produced per ton of coal, or about 4·5 cu. ft. per lb.

PRODUCER GAS.—Gas made by distilling coal in a closed furnace, using part of its own heat of combustion to effect the chemical reactions, is called producer gas.

There are several kinds of gas producers which have proved successful in practice, and in some of these coke, or anthracite, is used, while in others bituminous fuels are employed.

In every case, however, the gas is produced by passing steam and air through incandescent fuel contained in a furnace, when the following reactions take place: The steam (H_2O) combines with carbon, forming carbon monoxide (CO) and free hydrogen, and the oxygen of the air first combines with carbon to form carbonic acid (CO_2). This CO_2 then combines with more carbon in passing through the hot fuel, forming carbon monoxide. These reactions may therefore be expressed thus:—

$$C + H_2O = CO + H_2,$$
$$C + O_2 = CO_2,$$
$$CO_2 + C = 2CO.$$

In addition, a certain amount of marsh gas (CH_4) and carbonic acid (CO_2) is formed, so that the ultimate composition of the gas is: combustibles CO, H_2, and CH_4 diluted with the non-combustibles CO_2 and N.

The products of the various producers, though designated by the names of the inventors or designers of the apparatus from which they are produced—for examples, Dowson gas, Mond gas, Duff gas, &c.—are virtually the same; the only difference being that, in consequence of using a greater or less percentage of steam, there is a little more or a little less hydrogen in the gas, which is consequently a little more or a little less inflammable.

SUCTION GAS PLANTS.—A class of producers which are proving very successful in practice is that known as suction gas producers. These are designed for use with gas engines, and a typical example is shown in section and in elevation in the accompanying Plate. The fuel used in the producer is anthracite 'beans' or 'doubles', and is introduced through the feeder (8) into the hopper (9). Below the hopper there is an annular cylindrical well containing water, which serves as a boiler for supplying the necessary steam. This steam passes down the pipes (11) to the superheater (12), which is mounted upon a flat plate. This plate has a hole in the centre in which rest the bars of the fire grate. In the pit below the fire grate the steam and air used in the gas-making process mix before passing together through the fire. During the suction stroke of the gas engine, the mixture of steam and air is drawn through the incandescent fuel (where it becomes converted into producer gas), and then through the seal pot (16), the coke scrubber (21), and the sawdust scrubber (22), into the engine cylinder. The amount of gas generated is thus controlled by the engine, which, in a sense, makes its own gas just as it requires it. [H. B.]

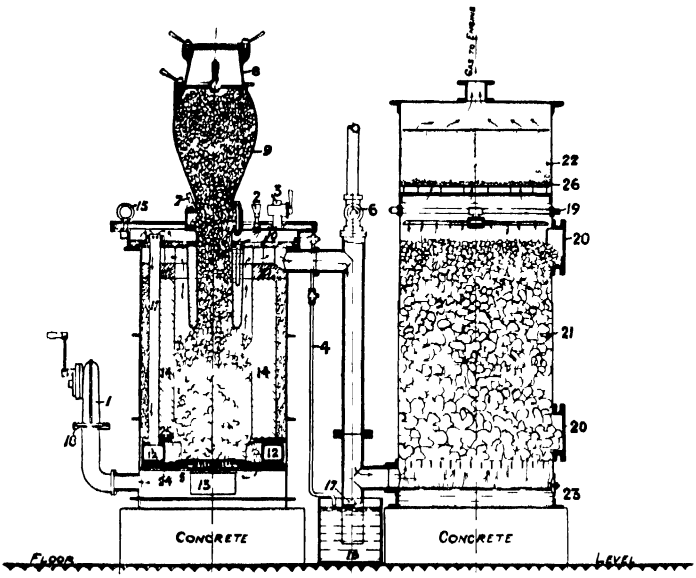
Gas and Oil Engines.—Gas and oil engines are internal-combustion engines. In a gas engine ordinary coal gas, or producer gas, mixed with atmospheric air, is exploded in a cylinder fitted with a movable piston. The explosion is accompanied by a considerable increase of pressure, which, acting upon the piston, drives it forward. The motion of the piston is then communicated, by means of a connecting rod and crank, to the crank shaft, causing it to rotate. In an oil engine, oil vapour takes the place of the gas in a gas engine, but in most other respects, both as regards construction and action, the two classes of engines are similar, and may therefore be considered together.

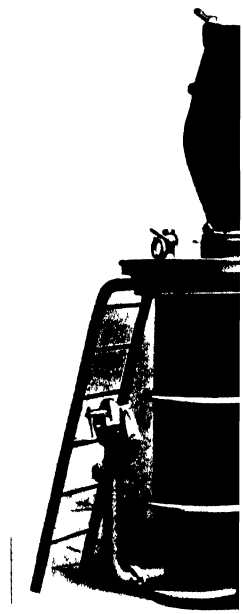
The cycle of operations followed out in gas and oil engines is that known as the 'Otto' or four-stroke cycle, which, assuming the engine to be running, may be described as follows:—

Suction Stroke.—During the first (outward) stroke, or by reference to fig. 1, A, while the piston P moves from left to right, gas and air, or oil vapour and air, are drawn through a valve or valves into the cylinder; the valves remaining open until the piston gets to the end of its stroke, when they are closed.

Compression Stroke.—During the next or second stroke of the cycle all valves are closed, so that the confined gaseous mixture is gradually compressed, as represented by the line *cd*, fig. B, to about 90 lb. or 100 lb. per square inch.

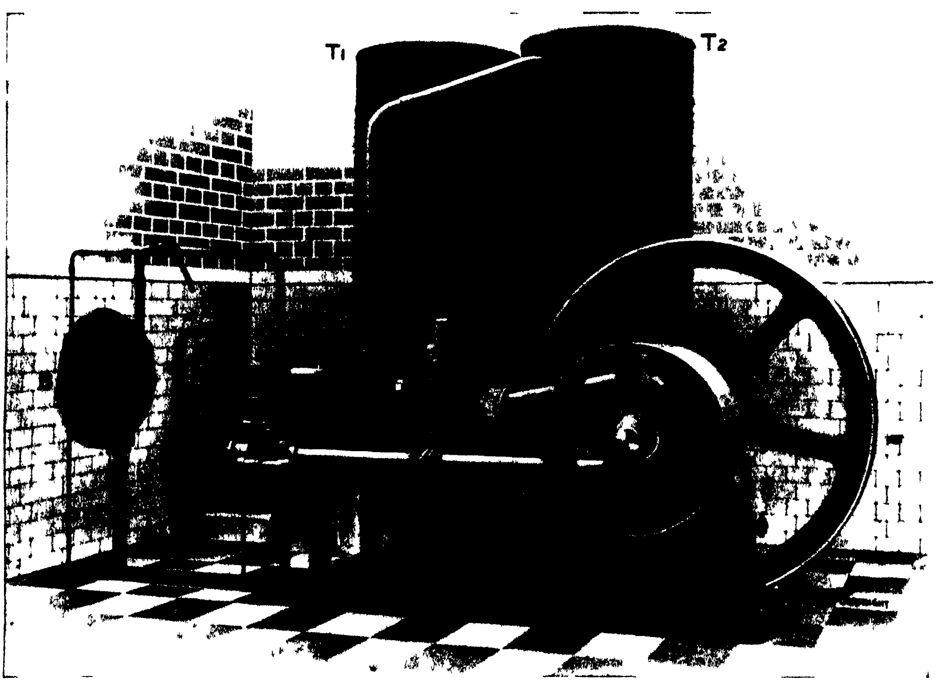
Working Stroke.—At the beginning of the next or working stroke, ignition takes place, which is effected either by means of an electric spark, or by allowing a little of the explosive mixture to enter an incandescent tube kept hot by a Bunsen flame. The pressure then rises sud-



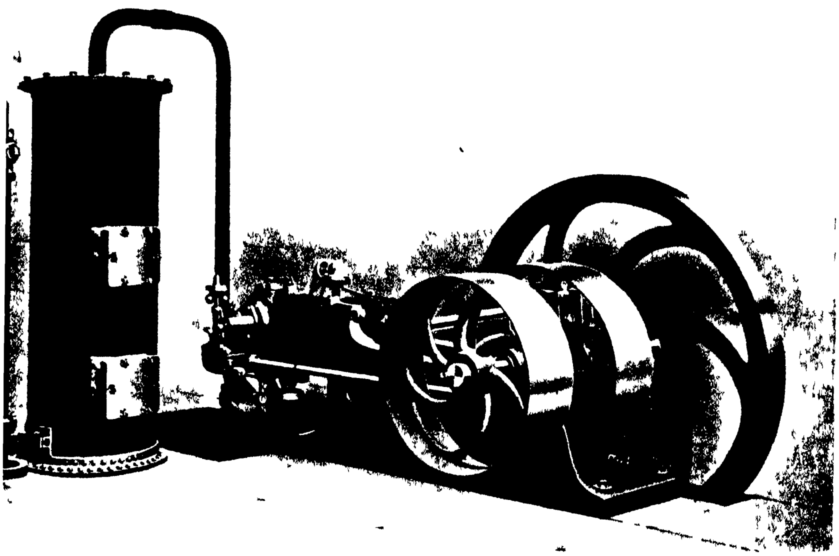


SECTION OF CROSSLEY'S SUCTION GAS PLANT

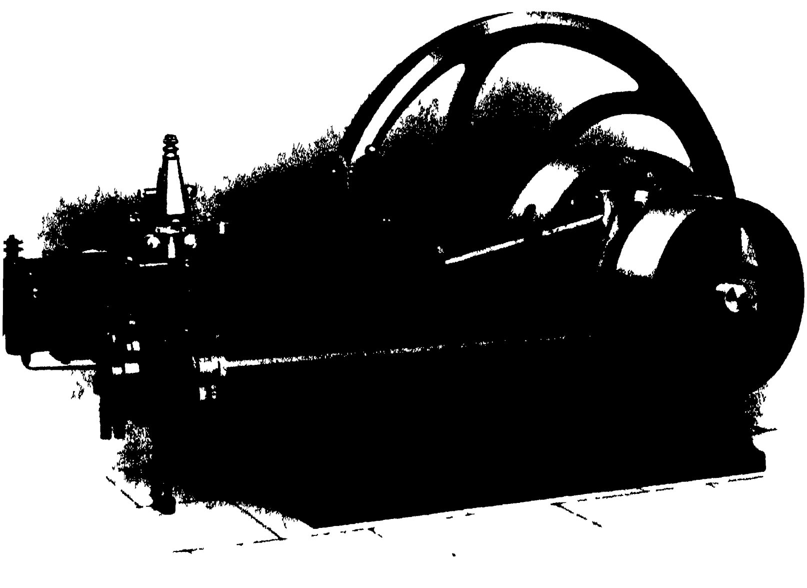
1, Hand Fan. 2, Feed Water for Vaporizer. 3, Air Regulating Cock. 4, Overflow from Vaporizer. 5, Firegrate. 6, Blow-off Cock. 7, Poker Holes and Plugs. 8, Feeder. 9, Hopper. 10, Vaporizer. 11, Superheater Pipes. 12, Superheaters. 13, Fire Doors. 14, Firebrick Lining. 15, Eye Lifting Bolts. 16, Seal Pot. 17, Overflow from Seal Pot. 18, Plate Damper. 19, Scrubber Water Supply Pipe. 20, Filling Doors. 21, Coke Scrubber. 22, Sawdust Scrubber. 23, Cleaning Door. 24, Firegrate Support. 25, Firebrick Support. 26, Layer of Shavings. 27, Fireclay.



STANDARD ARRANGEMENT OF GAS ENGINE USING "TOWN" GAS (Tangyes Limited)



IYS SUCTION GAS PLANT OPERATING GAS ENGINE



CROSSLEY OIL ENGINE

denly, as shown by the line *de*, fig. C, and the piston is driven forward under a pressure which falls gradually during the stroke, as represented by the line *ec*.

Exhaust Stroke.—During the next and last stroke of the cycle the products of combustion are expelled through the exhaust valve, which was opened just before the end of the third or working stroke of the cycle. At the beginning of the next stroke, the exhaust valve having been already closed, the gas and air valves are opened and the cycle of operations repeated.

Having only one working stroke out of every four, in order to keep the speed from fluctuating

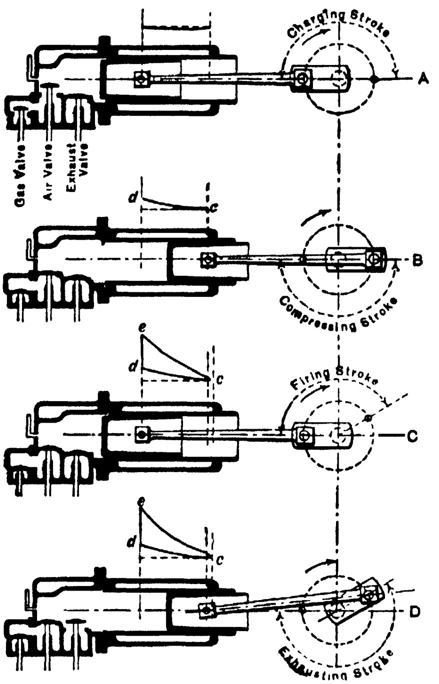


Fig. 1 - Diagrams showing working of Gas Engine Valve

too much, an engine working on the Otto cycle requires a large, heavy flywheel to carry it over the three strokes of the cycle when no work is being done upon the piston. For the same reason, as compared with steam engines, every stroke of which is a working stroke, gas and oil engines are heavy, cumbersome, and costly. In this respect, therefore, gas and oil engines are at a disadvantage; but, on the other hand, as compared with a steam engine and boiler combined, they have several very desirable advantages, namely: (1) They need very little attention; (2) as no boiler is required, they take up less space than a steam engine and boiler of the same power; (3) they can be started in a few minutes; (4) they are more economical than steam engines, especially when producer gas or a cheap kind of oil fuel is used, or when the engines are subject to frequent stoppages for short periods. For a small engine of say 20 or 25 horse-power working at full power, the consumption of fuel per brake horse-power hour will be: for a steam engine, 7 lb. or 8 lb. of coal, costing about one-third of a penny; for an oil engine, from 0·8 lb. to 1 lb. or from 0·8 pt. to 1 pt. of petroleum, costing about $\frac{1}{5}$*d.*; and for a gas engine using town's gas, 17 to 18 cu. ft. of gas, costing about $\frac{1}{2}$*d.* When suction gas is used, however, the cost of the anthracite 'beans' or 'doubles' used in the producer will amount only to about one-tenth of a penny per brake horsepower hour.

The usual arrangement of a small gas engine using town's gas as fuel is shown in Plate, and an elevation and plan in figs. 2 and 3. The cam shaft, S, which makes one revolution for every two of the crank shaft, is driven from the latter by skew or other gearing, and attached to it, near one end, are the cams for actuating the valves. During the suction stroke the gas is drawn from a reservoir or gas bag, B, having a flexible back, and which is provided so that the pressure may be nearly constant throughout the stroke. To keep the cylinder from getting too hot, a circulating cooling-water system is provided which works automatically as follows: In the barrel of the cylinder, between the internal and external surfaces, there is a water space (fig. 3), into which cold water flows from the bottom of the tank T_1. This water enters the water space at its lowest part, and, becoming warmer and lighter as it absorbs heat from the hot cylinder, rises automatically to the top of water space and up through the pipe shown in the Plate illustration, into the tank T_2 at the top. As the water cools in this tank it sinks to the bottom, then flows into T_1, and then back through the water space, &c.

In districts where town's gas is unobtainable or costly, producer gas (see GAS PLANTS) or oil fuel may be used with advantage, and in many cases these fuels may be used with advantage even where coal gas is obtainable at a moderate cost.

OIL ENGINES.—Oil engines are similar to gas engines, with the addition of an oil pump and a vaporizer. In the earlier forms of oil engines, and in those used in motor cars, very light inflammable oils of the gasoline and petrol kinds are consumed. Here the vaporization is readily effected by simply drawing air over a surface saturated with one of these light oils, or by throwing a jet of the oil into an air current, when a mixture of inflammable vapour and air is obtained, which may be used in place of the coal gas in a gas engine. These light oils, however, are too dangerous for use in large quantities within buildings, accordingly heavy-oil engines have been produced, in which any common petroleum lamp oil of the Russian, Scotch, or American brands, such as 'Russolene', 'Broxburn', 'Royal Daylight', &c., may be used. Such engines may be divided into three distinct classes:—

1. Engines in which the oil is subjected to a spraying operation before vaporization, such as Priestman's engine.

2. Engines in which the oil is injected into the cylinder and vaporized within the cylinder, as in the Hornsby engine.

3. Engines in which the oil is vaporized in a device external to the cylinder, and introduced into the cylinder in the form of vapour, as in the Crossley oil engine, a view of which is shown in Plate.

In this engine the vaporizer communicates with the cylinder by a vapour valve. The oil, which is stored in the foundation of the engine, is pumped into the vaporizer in exact quantities in proportion to the power developed by the engine. A lamp heats up the incandescent tube and also the vaporizer, and the waste heat passing up the funnel heats up the air supply. The mixture of oil-vapour and air is formed

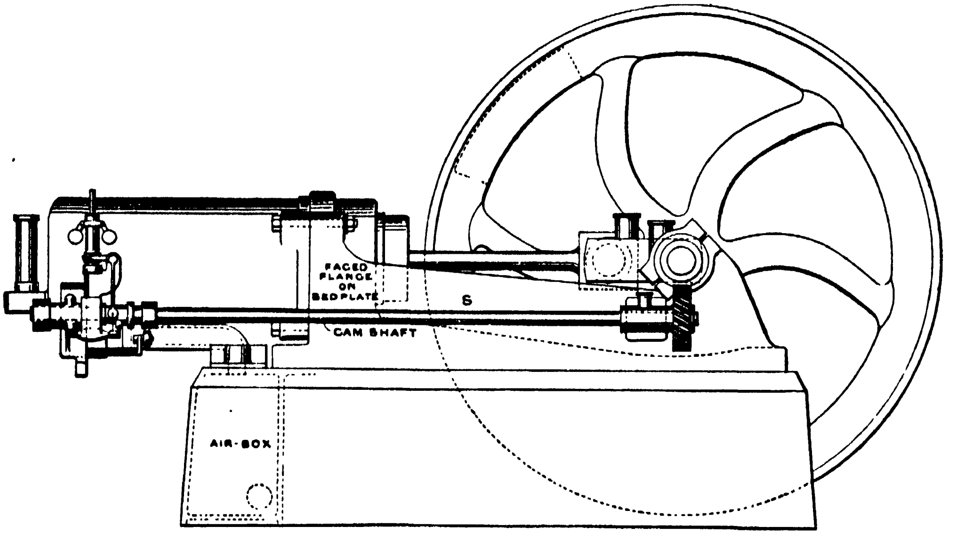


Fig 2

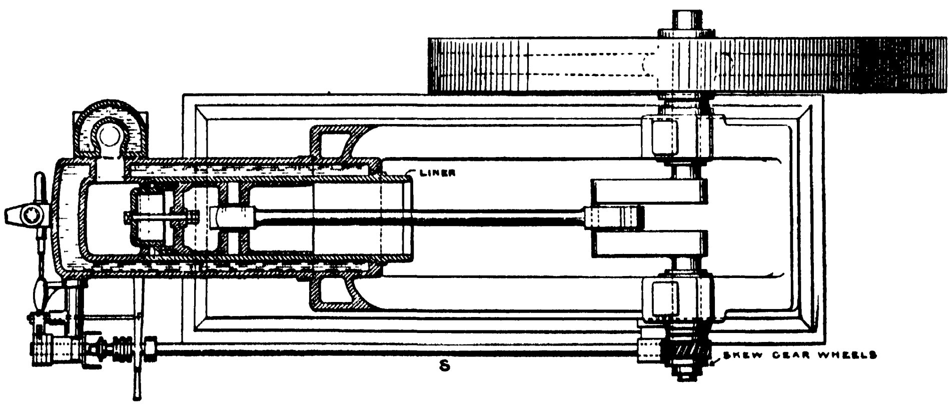


Fig. 3

Elevation and Plan of small Gas Engine

within the cylinder in the same way as gas and air are mixed in a gas engine. [H. B.]

Gaslight. See LIGHTING OF FARM BUILDINGS.

Gas Lime.—Coal gas, as it is given off in the destructive distillation of coal, contains small quantities of gases of an undesirable nature. These, before the gas is used for illuminating purposes, are removed. They consist mostly of compounds of sulphur, namely sulphuretted hydrogen, carbon disulphide, also some cyanogen, ammonia, and carbon dioxide. To purify the coal gas from these compounds it is first passed through water, which retains a large proportion of them, and results in the formation of ammoniacal or gas liquor. From there it is made to pass into chambers with shelves holding slaked lime. The lime absorbs most of the compounds of sulphur, as shown in the following reactions:—

$$Ca(OH)_2 + H_2S = CaS + 2H_2O,$$
$$CaS + CS_2 = CaCS_3.$$

Carbon dioxide gas is also absorbed as follows:—

$$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O.$$

The spent lime resulting is called gas lime, and

it consists of a complex mixture of sulphide, thiosulphide, sulphate, sulphite, sulpho carbonate, carbonate, thiocyanate, and hydrate of calcium, together with small quantities of ammonia, cyanides, and ferrocyanides, &c.

The percentage composition of gas lime is shown in the following analysis:—

Calcium hydrate	15·10
,, carbonate	24·20
,, thiosulphate	11·80
,, sulphide	6·90
,, oxysulphide	3·20
,, sulphate	0·25
,, sulphite	1·50
,, cyanide	0·25
Iron sulphide	0·55
Sulphur	4·30
Silica	1·80
Alumina	0·70
Magnesia	trace
Tar	0·25
Water	29·25
	100·00

Traces of ammonia are generally present in gas lime; the amount varies, and it sometimes reaches as much as ·25 per cent.

Many of the compounds in fresh gas lime are active plant poisons; on exposure, however, to air and rain, and more especially when mixed with soil, ditch cleanings, and other similar material, absorption of oxygen slowly takes place, and the injurious constituents, namely the sulphides and sulphites, &c., become oxidized into harmless but useful manurial substances. The chemical action is shown in the following equations:—

$$2CaS + CO_2 + 4O = CaS_2O_3 + CaCO_3,$$
$$CaSO_3 + O = CaSO_4,$$
$$CaS_2O_3 + 2O_2 + Ca(OH)_2 = 2CaSO_4 + 2H_2O.$$

Fresh gas lime must be exposed to air for at least three months before it can be applied with safety to pasture land or any other growing crops as a manure.

When completely oxidized, gas lime forms a very useful manure. It is, however, variable in composition, and may contain as much as 40 per cent of calcium carbonate and 15 per cent of slaked lime; but these substances vary according to the quality of the lime used in the purifiers, to the time the lime has been kept there, and to the nature of the coal gas.

Apart from the nitrogen gas lime may contain, the comparatively large amounts of carbonate and slaked lime present makes it a very valuable manure for many purposes. It is not so effective as quicklime, but it can be used with advantage on all those soils to which lime is applied. Its real value as a manure depends upon the amount of nitrogen, carbonate of calcium, and slaked lime it contains. It is found to be specially suitable for application to leguminous crops, and it can also be applied to advantage on grass land for killing out moss and coarse grasses. It is highly recommended for root crops, and when applied at the rate of 5 tons per acre to lea before ploughing, it is found to be a very efficient manure for the oat crop following. [R. A. B.]

Gassy Cheese and Milk.—The swelling and puffing of cheeses that are ripening is common enough in cheeserooms attached to old-world dairies, where the milk is not 'ripened' for cheesemaking. In other cheeserooms, too, it is known, but is easier to deal with there. A 'gassy' condition is evidence of fermentation in cheese and in milk, and therefore of the activity of certain bacteria whose action brings about the condition indicated by the word. The evolution of this gas is, further, an indication of incipient decomposition, should nefarious bacteria be producing it; or of normal digestion, should the milk have been ripened by the lactic ferment and coagulated by the action of a cleanly rennet ferment. In the latter case the difficulty of dealing with it is met by the insertion of a skewer, which liberates the gas, and the cheese ripens naturally and well. But in the former the ripening goes on wrong lines, and should be called decay, for the cheese is vitiated by peculiar flavours produced by the bacteria in possession, of whatever sort they may be. It will be understood that each yeast or ferment taking possession of curd contributes a special flavour to the cheese, and some of these produce gases to a considerable extent. The best way of preventing gassy cheese and milk is to promote the development of the lactic ferment; this will checkmate all others, once it obtains possession of the milk. It is then 'the one leaven that leaveneth the whole lump'. [J. P. S.]

Gastritis.—Inflammation of the stomach, either acute or chronic, is a disease to which all species are liable. Horses suffering from the acute form show symptoms of brain pressure recognized as stomach staggers, sleepy staggers, and mad staggers—terms which describe the various effects upon different individuals whose stomachs have become distended and inflamed by feeding upon coarse innutritious substances, or which have been indulged in the stable with an excessive amount of corn and with inadequate exercise. A profound somnolence while standing, from which the subject can with difficulty be aroused, and into which he again quickly passes; an unsteady gait in the field, with lowered head, mark the invasion of stomach staggers: after which the blown appearance of the belly may be more noticeable, as gas is evolved from the contents so soon as the paralysis of the viscus is established. A few animals become delirious before death, or display symptoms of mad staggers and fall only to die after a brief riot, in which persons may be injured. When acute gastritis is caused by yew poisoning there is collapse and nervous prostration, and if arsenic or carbolic acid has been the cause, much frothing of saliva and swollen lips, with ropes of fœtid saliva hanging from the mouth.

Treatment.—If it is known to be due to an irritant poison, antidotes will be first administered (see art. POISONS AND ANTIDOTES), and then the usual soothing sedative remedies applicable to other cases, as bismuth and gum acacia, glycerine and hydrocyanic acid (see MEDICINE, DOSES OF); and if the patient rallies,

a careful dietary must be followed for some time —linseed, milk, eggs beaten with milk, carrots, bran mashes, scalded hay, &c.

Chronic gastritis is apt to be the sequel to the acute form already described. It also results from the artificial feeding with cooked foods by which horse dealers make up horses for sale, and is followed by failure to digest the ordinary corn ration and dry forage in the new home of the animals when sold. The same coarse and innutritious foods, alluded to as causes of impaction and of colic (see those diseases), also give rise to chronic gastritis, with symptoms only less marked than those mentioned in connection with the acute form, and with such as are generally associated with indigestion (see COLIC).

Gastritis in cattle is generally cured by abstinence from food; but a return to health and digestive power is facilitated by a bold purgative, followed by doses of calumba and bicarbonate of soda (see MEDICINE, DOSES OF). Pigs and dogs frequently vomit, and then drink copiously afterwards, the water taken having the effect of washing out the organ and acting as a gastric sedative. The ailment is quickly controlled by hydrocyanic acid and soda or bismuth in doses proportioned to the species, size, weight, and condition of the animal. The reader is recommended to look up the doses of these substances under their various headings in the article already referred to. [H. L.]

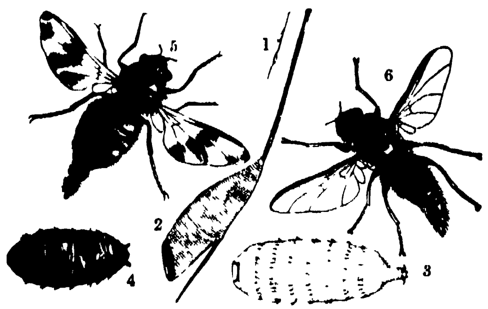
Gastroidea polygoni (the Knotweed Beetle), a metallic-blue beetle, with red thorax and apex of the abdomen; legs red, except the tarsi; antennæ dark-red at the base. Length, 3 to 5 mm. The females when full of ova have their bodies much swollen and protruding beyond the elytra. They lay their eggs on leaves, and the pale-coloured larvæ have numerous dark spots and also tubercles in front, which can exude a liquid. They normally feed on Polygonum and Rumex, but also attack wurzel, kohlrabi, and large bindweed (*Convolvulus sepium*). [F. V. T.]

Gastropacha quercifolia (the Lappet Moth).—The large caterpillars of this moth frequently occur on plum and apple, and devour an enormous amount of foliage. They grow to 4 or 5 in. long, and are of a greyish-brown colour, with V-shaped dark marks down the back. These marks vary or may be absent, but on segments two and three there are always two deep-blue lustrous velvety bands; at the sides are fleshy warts with long grey hairs, lappet-like, hence the name. The larva hatches in September and feeds for a time, then it moults, and remains all the winter stretched out on the bark on a twig or shoot; in the spring they commence feeding; by June they are full fed, and then seek any convenient shelter, where a dark-coloured elongated oval cocoon is spun, of varied shades, usually mouse-coloured, in which pupation takes place. The pupa is very active, and the whole cocoon is seen at times to move. The moth hatches in July and August as a rule, but is said also to occur as early as May. The female is 3½ in. across the wings, the male about 2 in.; the colours are rich-brown, the front wings with darker irregularly scalloped transverse lines; the hind wings very similar, and both pairs much scalloped at the edges. When at rest the front edge of the hind wings projects beyond the fore wings.

Treatment is usually confined to hand-picking; but where they are very numerous, arsenate of lead may be employed. [F. V. T.]

Gastrophilus, a genus of flies of which the chief is *G. equi*, the Horse-bot Fly. It frequents meadows and heaths during the summer months, where horses are feeding. It is in their larva state that these insects are called bots, and they occasionally exist to so great an extent as to affect the health, if not the life, of the host. The habits of the following species vary a little:—

G. equi is a fly which hovers about horses, bends her 'tail' under her body, and by means



Gastrophilus equi (Horse-bot Fly; figs 1–5)

1, 2, Egg attached to hair, nat size and magnified; 3, larva, 4, pupa, 5, fly, slightly magnified. 6, *Gastrophilus hæmorrhoidalis* (Red-tailed Horse-bot Fly)

of an ovipositor, deposits her eggs singly upon the hairs, to which they firmly adhere, so that the legs are often covered with these nits; and such is the wonderful instinct of the fly, that the eggs are usually laid upon those parts which the horse is able to reach with his tongue. By licking itself, the maggots are either squeezed out of the shell, or the warm saliva and rough tongue loosens the eggs, and they are at once conveyed into the stomach, where they become prickly larvæ called bots, which adhere to the coats by two sharp mouth hooks. Having remained there, feeding, in a very high temperature, for many months, they at last relax their hold, and pass off with the excrement through the intestines, and falling upon the ground, they change to puparia in and on the ground, and from these the flies hatch.

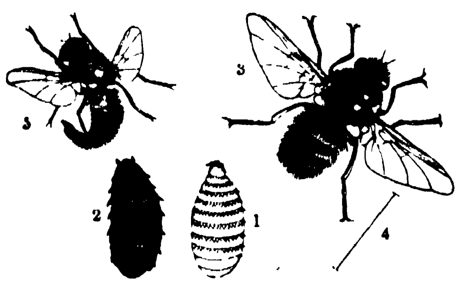
The eggs are whitish, transversely striated, pointed at one end, and cut off sloping at the other (figs. 1 and 2). The larvæ are grey, creamy, and sometimes tinged with pink, composed of rings which have a double row of short spines surrounding them, and two hooked mandibles in the mouth (fig. 3). The puparium is oval, pitchy, with several rings of short spines, and two little sort of horns at the head (fig. 4). The flies are tawny and hairy; the eyes black, thorax black, forepart clothed with yellowish hair; body variegated with brown and shining

hairs; wings with pale smoky spots; legs moderately long, slender, and spotted, terminated by two claws and two little lobes called pulvilli. Female with a blackish horny tube at her tail.

G. hæmorrhoidalis (the Red-tailed Horse-bot Fly) is smaller and black; head and forepart of trunk clothed with yellowish down; wings unspotted; legs and three terminal joints of body, ochreous (fig. 6 shows the female twice as large as life). The eggs are laid on the lips of the horse, but the larvæ live in the stomach, and they hang on the fundament before falling to the ground to become puparia.

G. nasalis (the Red Horse-bot Fly) is another species, which lives in the intestines of horses. The fly is clothed with fulvous hairs, sides of the trunk and base of the body with white tufts.

G. salutiferus (the Stomach Horse-bot Fly) is merely a variety of *G. nasalis*, and is produced



Gastrophilus salutiferus (Stomach Horse-bot Fly)

1, Larva; 2, pupa; 3, 4, male fly; 5, female.

from a smaller larva (fig. 1) than that of *G. equi.* The pupa (fig. 2) is similar, but the fly is very different; the male (fig. 3) is clothed with orange hair; base of the body yellowish; legs tawny. The female (fig. 5) has a black body, clothed with yellowish down, excepting a band across the middle and the tip. The chief thing to prevent bots in horses is to see that they have plenty of shade when turned out at grass, as the bot flies will not enter it, and so the horses can protect themselves. Water is equally good, horses always running to it and standing in it when the flies are active. The nits should always be removed when seen on the knees, legs, or shoulders, where they have now and then been found. For treatment see art. BOTS.
[J. C.] [F. V. T.]

Gates.—This subject is fully treated under the head of FENCES, to which the reader is referred.

Gault Clay, a strong tenacious clay of a bluish colour belonging to the Upper Cretaceous formation. See CRETACEOUS.

Gaultheria, a genus of Ericaceæ, comprising about a hundred species of ornamental small trees or shrubs, mostly indigenous to America, a number of them being hardy in this country. Two of the evergreen kinds are valuable garden plants. These are: *G. procumbens*, the Creeping Winter Green or Partridge-berry, of trailing habit, attaining only a few inches in height, bearing small white flowers in July and edible red berries; and *G. Shallon*, the Salal or Shallon, 3 ft. in height, of a dense, robust habit, with pinkish flowers and purplish berries of excellent flavour. These plants are well adapted for forming a carpet of undergrowth, and might well be more generally employed for planting in coverts. They prefer a peaty soil, and are easily increased by division. [W. W.]

Gayal or **Mithan** (*Bos* (*Bibos*) *frontalis*) are large cattle kept in a state of domestication by the Indo-Chinese tribes of Assam, Manipur, Cachar, and Chittagong. The Gayal is a heavily built animal, closely allied to the Gaur or Indian Bison (*Bos* (*Bibos*) *gaurus*), and very possibly only a domesticated breed of that species, from which it differs in being smaller, shorter in the skull and legs, provided with a heavy dewlap, and with shorter, more massive, and less curled horns; usually also the area between the horns is less convex. The legs below the knees and hocks are white in the adult, but the rest of the body and head is typically almost black, with the exception of the hairs on the forehead, which are iron-grey. Piebald examples are not uncommon. There are considerable doubts as to whether the Gayal represents a genuine species or not. It is said that wild examples have been met with, but these may be merely individuals that have strayed into the jungle and returned to a savage state, like some of the domestic buffaloes. The natives who keep these cattle use them for food; but not apparently for milk, nor as beasts of burden. The herds roam freely in the jungle by day, and return to their owners' villages at night. They breed readily with zebus and other domestic cattle. [R. I. P.]

Gean, the common name for the Wild Cherry. See WILD CHERRY and CHERRY.

Gear, Gearing.—When two machines are connected together in such a way that the motion

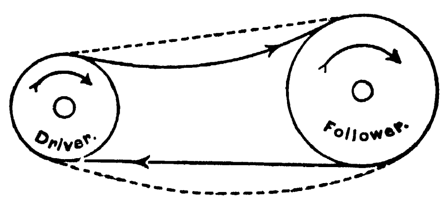


Fig 1

of the one is communicated to the other, the machines are said to be in *gear* or *geared* together, and the mechanism by which the motion is communicated is called a *gear* or *gearing*. The terms *gear* and *gearing* are also used in a wider sense to indicate the combination of any number of parts of a machine which are employed for a common object. The types of gearing most frequently used in practice may be divided into: (1) Gearing in which flexible connectors are used, as in belt, rope, and chain gearing; (2) toothed gearing, including spur, bevel, screw, and worm gearing; (3) friction gearing. In belt gearing the belts are usually flat, and are used on pulleys with flat or slightly rounded rims. The belt connecting two pulleys will be open or crossed

according as to whether the pulleys are to run in the same or in opposite directions. When open belts are used they should be so arranged that the lower 'reach' or side of the belt is the tight or driving side, as shown by the *full* lines in fig. 1; for then the arc of contact of belt and pulley, and consequently the frictional resistance between them, will be greater than they would be if the upper side of the belt were, as shown by the dotted lines, the driving side. When the pulley shafts are not parallel, in order that the belt may work properly the pulleys must be so arranged that the point *a*, fig. 2, at which the belt leaves one pulley, A, lies in the plane of the other pulley, B; and the point *b*, at which it leaves the latter, lies in the plane of the former pulley A. The pulleys will then work properly, but in one direction — that indicated by the arrows—only. If they were required to work

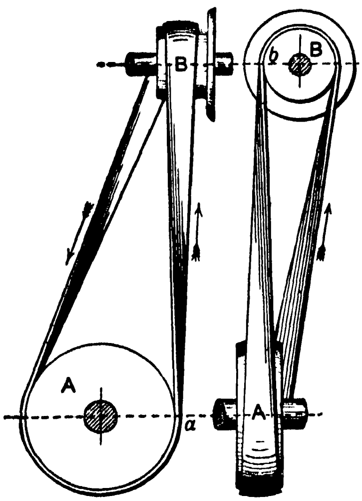


Fig. 2

correctly in both directions, *guide* pulleys would have to be used.

For indoor work the belts commonly used are of leather tanned by oak bark, and are from $\frac{3}{16}$ in. to $\frac{5}{16}$ in. in thickness when single, or from $\frac{3}{8}$ in. to $\frac{5}{8}$ in. when double, *i.e.* when formed by riveting or cementing two pieces of single thickness together. If B be the breadth in inches of a belt of single thickness, and V its velocity in feet per minute, the horse-power (H.P.) which it can safely transmit varies with the thickness from

$$\text{H.P.} = \frac{B \times V}{1100} \text{ to H.P.} = \frac{B \times V}{800}.$$

For outdoor work, or where there is much moisture about, leather belts are altogether unsuitable; consequently under such circumstances other kinds of belting are used, such as waterproofed woven cotton, or canvas and indiarubber belting. In rope gearing, hempen, cotton, and steel-wire ropes are used. With hempen or cotton ropes the pulleys used have V-shaped grooves in the rims, and the ropes, in passing over the pulleys, become wedged in these grooves, thus increasing the frictional bite of the pulley and, consequently, the power which can be transmitted by the ropes without slipping. With wire ropes this wedging action, of course, cannot be allowed, and the groove therefore is made wide so as to allow of the rope resting freely upon the bottom. Chain gearing, consisting of

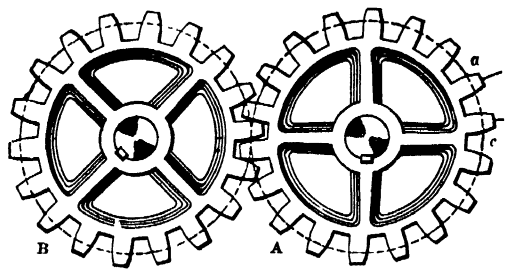


Fig 3.—A Pair of Toothed Wheels

roller chains working on sprocket wheels, is now much used for implements, motor vehicles, workshop tools, &c. It is a positive method of driving, and combines the advantages of wheel gearing with the simplicity of belt driving. When considerable power is to be transmitted between two parallel shafts not far apart, or when the velocity ratio between them is to be exact, the shafts are usually connected by spur gearing or cylindrical toothed wheels in which the teeth project radially along the circumference, as shown in fig. 3. If both wheels, A and B say, have the same number of teeth, B will make a revolution for every revolution of A; but if B has only half the number of teeth of A, B will make two revolutions for one of A. And generally, if driver A, say, has N_1 teeth and the follower, B, N_2 teeth, in any given interval of time—

$$\frac{\text{revolutions of the follower}}{\text{revolutions of the driver}} = \frac{N_1}{N_2}.$$

Similarly, if we have a train of wheels, as shown in fig. 4, of which A, B, C, &c., represent

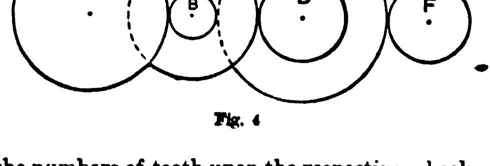


Fig. 4

the numbers of teeth upon the respective wheels, then, assuming A to drive B, C to drive D, E to drive F, &c., B will make $\frac{A}{B}$ revolutions for one of A, D will make $\frac{C}{D}$ revolutions for one of B or C, or $\frac{C}{D} \times \frac{A}{B}$ for one of A, and F will make $\frac{E}{F}$ revolutions for one of E or D, or $\frac{E}{F} \times \frac{C}{D} \times \frac{A}{B}$ revolutions for one revolution of A. Hence the

value of the train, which = revolutions of last wheel in the train $\div$ revolution of the first, $= \frac{A \times C \times E \times \ldots}{B \times D \times F \times \ldots}$; that is to say, the value of a train of spur wheels

$$= \frac{\text{continued product of numbers of teeth on drivers}}{\text{continued product of numbers of teeth on followers}}.$$

Pitch Circles.—The velocity ratio communicated between a pair of spur wheels in gear is

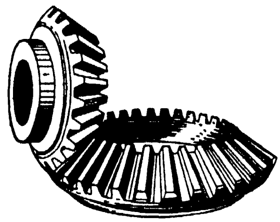


Fig 5.—A Pair of Bevel Wheels

the same as that which, rolling together, would be communicated between a certain pair of circles, shown dotted in fig. 3, which touch one another and have the same centres as the wheels. These circles are called *pitch circles*, and by the diameter of a spur wheel is meant the diameter of its pitch circle. The pitch of the teeth of a spur wheel is the distance, as measured along the pitch circle, of the centre line of one tooth to the centre line of the next tooth, or the distance marked *a c* of wheel A, fig. 3.

When motion is to be communicated between two shafts which are not parallel but intersecting, bevel gearing, as shown in fig. 5, is employed; but when the shafts are neither parallel

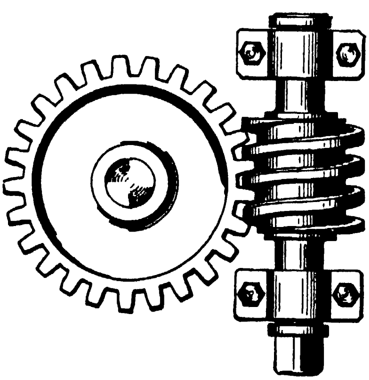


Fig. 6.—Worm and Worm Wheel

nor intersecting, they are often connected by skew bevel wheels.

For communicating a slow motion to one shaft from another at right angles to it and moving much more quickly, worm gearing, as shown in fig. 6, is employed, consisting of a worm on the latter shaft gearing with a worm-wheel on the former, and for converting a motion of rotation into a slow reciprocating motion a screw working in a nut is often used.

Friction gearing, consisting of friction clutches or couplings, is used where machines are required to be put in and out of gear quickly and without shock. [H. B.]

Geese, Breeding of.—The only section of poultry breeding in this country which has shown any decline within recent years is that of geese, and the same change is to be met with in other countries of western Europe. In eastern Europe there is no such reduction, due to the fact that in Germany the demand for goose flesh is as great as ever, and probably has grown to a considerable extent. The reasons for the decline referred to are twofold: first, that with the greater amount of enclosure of cultivated land, and the consequent limitation of open spaces of small value, the opportunities for keeping these birds have been greatly reduced. Formerly, when common land was found in almost every village, large numbers of geese were kept and bred by cottagers and others. But with the abolition of commons the number of geese maintained throughout the country has declined; and second, the advent of the turkey has greatly reduced the demand for geese, more especially at the Christmas season, when the finer flesh of the turkey is preferred to the rich, fatty meat found on the goose. Under ordinary conditions, reduction of supply would have meant an advance in price, but it is evident that the sale has decreased to an even greater extent than the supply, for the rates obtainable for geese are lower than was the case ten to twenty years ago. A mistake was also made by breeders in producing too large specimens, which were beyond the purchasing power or requirements of the ordinary householder. Continental breeders have not made this error. In the markets of south Germany, Austria, and adjacent countries, well-fleshed specimens weighing about 8 to 10 lb. are in large demand, and it is probable that were these available in Britain they would find a ready market.

Wherever geese are produced, the work must be conducted on inexpensive lines, which is possible where land is cheap and open, yet good enough to provide a large portion of the food required by the birds during the growing stage. Hence low-lying fen or meadow land is specially favourable, or the higher lands, which are usually fairly moist, so that grass and other herbage grows freely. It is for this reason that geese are more largely kept in the grazing than in the corn-growing districts. We must remember that geese are essentially grazing poultry, and if they are to be reared with profit to the owner they must find practically all their food during the summer months. In Ireland, western and eastern Germany, and Russia the young birds are not fed at all after they are eight or nine weeks old, but must forage for what they require. Under these conditions, production is low in cost; but during a hot, dry summer, when grass is scanty, the birds suffer, and the owners lose heavily, as in the case of all other stock. But when the conditions are favourable, then the expense of rearing is very small indeed. It may be conceded that this system does not conduce to improvement of quality, but at the present

time it is the only method which yields even a moderate amount of profit. With a better demand there are many parts of Britain where considerable quantities of geese could be reared at small expense, to be afterwards sold to farmers for fattening off. In the absence, however, of that demand, or of the better prices which would follow, the encouragement is not great. In those districts either under rich pasture or tillage, farmers are well advised not to take up geese breeding, as these birds are heavy, and would do a considerable amount of damage to growing crops.

Geese require to be well housed, and the buildings must be spacious and well ventilated,—in fact they are better if open fronted, or have strong bars in front instead of a solid wall. As a rule, geese make excellent sitters and mothers. The natural system of hatching, which takes about thirty days, and rearing must be adopted. In fact, even if artificial methods were successful, there is no advantage in their adoption, as very early hatching is neither necessary nor desirable, except in the case of green goslings, for the hatching of which ordinary hens are to be recommended. During the rearing stage the mother should be cooped for the first ten to fourteen days, after which both old and young may be given their liberty and encouraged to find as much of their food as possible. During the early stages the goslings should be fed upon wheat or oats steeped for several hours and dried off by meal, such as barley meal or fine thirds. An excellent arrangement is to boil small potatoes and mix in a mashed state with the food. Where grass and vegetable growth is abundant, after two or three weeks it will only be necessary to give one feed of meal mixed with water in the morning, and a good feed of steeped grain in the evening, the former of which can be stopped when the birds are eight or nine weeks old, if green food is plentiful.

In many arable districts it is customary for farmers to buy a flock of geese in August or September, for which trade large numbers are brought over every year from Ireland and the Continent. They are fed off upon the stubbles, where they gather up the fallen grain that would otherwise be wasted. The cost of feeding in this case is very small indeed, and that part of the trade is profitable. Lean goslings can be purchased in many markets at 2*s.* to 2*s.* 9*d.* each, and the additional food to that obtained as stated above entails the expenditure of a very few pence. In some cases they are penned upon roots like sheep. There can be no question that the birds fatten rapidly under this treatment, and that the flesh produced is very fine in flavour and quality, whilst with an increased demand for Michaelmas geese the work could be made profitable. For the winter markets another plan is adopted, and this business is usually in the hands of special feeders, who buy older birds in large quantities and feed them in a wholesale fashion. In these circumstances the birds are divided into flocks of about twenty each, as near in size as possible, and kept either in special houses built for the purpose, or in empty pig sties with yards in front, so that they are strictly in confinement. They are fed for four weeks, the morning feed consisting of barley meal, Indian meal, and pollard in equal parts, mixed with water, and in the evening steeped oats or wheat. During the day, roots or green stuff should be supplied, and an abundance of grit and clean water to drink. [E. B.]

Geese, Breeds of.—The more prominent races of geese are treated separately (see CANADIAN GEESE, DANUBIAN GEESE, EMBDEN GEESE, ROMAN GEESE, SADDLEBACK GEESE, TOULOUSE GEESE), but there are others which require mention.

Chinese and African Geese are very similar, except that the last-named are the larger. As a rule they are somewhat shallow in body, with long necks and heads, and are altogether slighter in build than European geese. A peculiarity is that on the head is a horny protuberance at the base of the bill, which in the males stands out well in front. Of the Chinese there are two colours, the White and the Brown, whilst the African are grey in plumage. The flesh is fairly abundant, but somewhat hard.

Egyptian.—In north-eastern Africa geese are found over a very wide area, and for thousands of years they have been bred in Egypt, where at one period they were regarded as sacred birds. What is known as the Egyptian goose has a long ancestry, but it is chiefly kept for ornamental purposes, owing to its inferiority in flesh qualities to the Embden and Toulouse. These birds are very quarrelsome, but hardy and quick growers. The plumage is a speckled iron yellow on the breast, and grey with black markings on the back; the tail and wings are green, the latter having a bright bar.

Russian.—In the empire of the Tsar, at one time, goose fighting was a recognized sport, and that has greatly influenced some of the breeds kept, which are large in body, with powerful wings and muscles, thick neck, and stout head. The bills are very short, to enable the birds to keep a grip on their opponents. There are two varieties, the Arsamas, which have pure-white plumage, and the Tula, which are grey. Another is the Kholmogory, differing in that they are longer in neck, head, and bill. See also art. GOOSE. [E. B.]

Gelatin, Gluten, or **Isinglass** is obtained by digesting skins, tendons, bones, hoofs, fish bladders, &c., which have been crushed to a pulp, with water at a temperature about 175° F. The gelatin dissolves in the hot water. After separating the solution from the undissolved material, fats, &c., it is evaporated, preferably *in vacuo*, and the crude gelatin solidifies out. The animal colouring bodies are extracted from the solution containing the gelatin by charcoal, or bleached by sulphur dioxide. Glue is impure gelatin; isinglass is a form of gelatin obtained from the dried swim bladder of fish. Several kinds of isinglass, according to its source and appearance, are made.

Pure gelatin is an amorphous, brittle, transparent, tasteless, inodorous substance, neutral to test paper, and remains permanent in dry air. It is soluble in hot water, from which it can be precipitated by absolute alcohol, tannin, corro-

sive sublimate, &c. When moist or in solution it soon putrefies, and finally evolves ammonia. Warm solutions of gelatin set into a jelly on cooling; on prolonged boiling with dilute acids, gelatin yields leucin, glycine, alanine, proline, arginine, and several other amino acids. It belongs to the important class of substances called proteids. It is employed largely for culinary purposes, though its exact value as a foodstuff is uncertain. As stated above, gelatin combines with tannin to form an insoluble compound. It is the formation of this body that underlies the process of tanning. Skins contain gelatin, and when soaked in a solution of tannic acid the deposition of the compound of tannic acid with gelatin throughout the hide renders it impervious to water and of greater strength. The product is leather.

Gelatin is adhesive. It is used in making photographic plates and emulsions, for taking impressions and casts, for dyeing, printing, and sizing of paper, for clarifying beer, wines, &c. When mixed with potassium bichromate and exposed to sunlight, it is converted into an insoluble body; for this reason it is used in making an insoluble glue, and as waterproofing material. [R. A. B.]

Gelding, a castrated animal, especially a castrated horse. See CASTRATION.

Gelt Gimmer, a barren ewe, or a ewe which has failed to produce a lamb.

Genista, a large genus of shrubs, with yellow flowers, closely related to Cytisus (nat. ord. Leguminosæ), for the most part natives of the Mediterranean region. A number of them are hardy. Some species are prickly, others unarmed, and they range in size from tiny procumbent shrubs, such as *G. pilosa*, which is useful for carpeting, up to *G. ætnensis*, Mount Etna Broom, 10 ft. or more in height. *G. anglica*, Needle-gorse, whose flowers have an explosive mechanism, typical of many of the Leguminosæ; *G. tinctoria*, Dyer's Greenweed, and *G. pilosa*, Greenweed, are the British species. In addition to those named, *G. hispanica* (Spanish Gorse), *G. radiata*, *G. sagittalis*, and *G. virgata*, a large bush covered with bright golden-yellow flowers in May and June, are all good garden plants. For details of management see CYTISUS. [W. W.]

Gentian.—Gentian, or Gentiana, is a genus of herbaceous dicotyledonous plants which gives its name to the nat. ord. Gentianaceæ. The leaves are very characteristic, being opposite and three-ribbed. The petals of the flower are grown together, forming the gamopetalous corolla, to the interior of which the stamens are fixed. The ovary is placed within the corolla and is one-chambered, with many ovules attached to its wall. When ripe, this ovary becomes a two-valved capsule containing many small seeds. There are many species of this genus found both in the eastern and western hemispheres, and extending from the Tropics to the Arctic regions. A few species are British, and occur for the most part in hill pastures; for example, the Field Gentian (*Gentiana campestris*) of pastures on chalk and limestone. This is a low, much-branched annual about 8 in. high, with a four-lobed flower inclining to blue. In gardens, Officinal Gentian (*Gentiana lutea*) is often grown. This is a perennial herb with a long bitter-tasted taproot and handsome yellow flowers. The dried roots of this species constitute the tonic gentian root sold by herbalists. [A. N. M'A.]

Geology, Agricultural.—Geology is the science that deals with the structure of the earth, and particularly with the constitution and past history of the portion accessible to us, which is called the crust. This crust is formed of rocks (a term that includes mineral aggregates of all kinds, loose or consolidated), which the surface agents, rain, rivers, and so forth, are continually attacking, causing them to decay in various degrees. The materials washed down from the more exposed surfaces are accumulated elsewhere to form new rocks. At the same time, forces within the earth, disturbing the equilibrium of the crust, elevate it in some places and depress it in others, thus bringing rocks from below into the region of attack, or giving space, by the formation of depressed areas, for the accumulation of great masses of new sediment. Geology has to take note of all these changes, long since past or still in progress; and the scientific study of rock masses has shown how materials formerly buried deep down in the crust have been crumpled together and upfolded, so as to give rise to a great diversity at the surface. The weathering and decay of these diverse materials, combined with the action of living things upon them, produces soils, almost as various as the rocks from which they are derived. Geology affects the agriculturist, then, mainly in pointing out the relations of types of rock to the soils formed from them, and the areas over which, in any country, particular types of rock extend.

Water-supply, moreover, is largely a question of geology, especially when water is sought for in regions that are arid at the surface. The details of underground structure, which are studied in most cases purely in pursuit of scientific knowledge, and with a view to the complete understanding of a country, become of the utmost practical importance when settlers begin to require more water than the mere surface springs will yield.

Operations for the reclaiming of land must be largely influenced by geological considerations; so also must any drainage work undertaken on an extensive scale.

The earlier writers on the geology of our islands almost uniformly sought to connect their studies with the agriculture of the districts that they described. At the close of the 18th century, the country gentleman tended to become a scientific amateur. Collections of minerals were frequently formed in houses where the names even of the chemical elements would nowadays convey no meaning. William Smith, 'the father of English geology', made his appeal to men of intelligence primarily interested in the land, when he urged, in his earliest works, the importance of the study of our stratified deposits. The 'statistical surveys' published about that time give details as to the relations of the soils to the underlying rocks; and some of the

earliest geological maps, such as Sampson's of the county of Londonderry in 1802, and Greenough's of England and Wales in 1819, represent certain 'drifts' or superficial deposits, which are of immense importance to the farmer, but which were often omitted from later publications. The British Mineralogical Society, founded in London in 1799, offered in 1801 to examine for farmers, 'free of expense, all specimens of earths or soils' that might be sent to them, and the Geological Branch of the Ordnance Survey of Ireland established a bureau for soil investigation in Belfast in 1837. The rapid spread of discovery in regard to fossils and to the mineral structure of igneous rocks tended to draw off the attention of geologists, and even of official surveys, from the agricultural aspects of the science. Writers on agricultural chemistry, however, have continuously based their descriptions of soils on the facts revealed by geological study. In recent years, the 'drift maps' of the Geological Surveys in Great Britain and Ireland have furnished an explanation of the distribution of our soils. While on the earlier 'solid' maps the massive formations were practically the only ones represented, though they might be covered by 100 ft. of 'superficial' deposits, the later type of map shows the gravels, boulder clays, old river terraces, and so forth, which in so many places form the true subsoils with which the farmer has to deal. Even on the 'solid' maps, areas of peat and alluvium were usually represented.

It is often difficult to say when or where the geological structure of a district is going to be of importance to the agriculturist. The custom of instructing pupils in agricultural colleges in the broad principles of geology, so that they may appreciate not only the constitution of soils, but the geological map and description of any country in which they may be placed, is in the highest degree appropriate. Minute classificatory details should of course be passed over, and long lists of fossils seem especially out of place. But there is, strictly speaking, no agricultural mineralogy or agricultural geology as a separate science. The educated agriculturist applies what he has learnt of mineralogy and geology to his special needs. At the same time, geologists have too often forgotten that the loose materials of the earth's surface, formed by disintegration and frequently modified by man, are fundamentally a part of the earth's crust, and record the latest phases of the geological history of the globe. See also next article. [G. A. J. C.]

Geology, Stratigraphical.—This branch of geology deals with the description of *strata*, or of the layers formed by sedimentary rocks as they have been successively laid down. Whether deposited in a lake or an ocean, the stones and finer particles washed from the land become spread out in sheets with considerable uniformity. At one time the flood-waters bring down coarser material, at another only fine mud reaches the shore, the more pebbly detritus remaining up the country; and hence a change takes place in the grade of material laid down, and the *stratification* remains marked when the mass becomes converted into solid rock in the course of time. Shell-fish and other animals with calcareous hard parts may accumulate in certain feeding-grounds, or the shells of smaller animals that swim on the surface of the ocean may be showered down to form beds upon its floor; and in this way layers of limestone become added to the earth's crust. All these rocks form a stratified series, which may attain an enormous thickness in the course of time, when, as so often happens, the ground steadily sinks under the increasing load placed upon it.

When, by the mysterious movements that take place within the crust and shift the boundaries of land and sea, these strata become lifted high and dry, they are commonly tilted or folded, and their exposed portions become worn down by the weathering action of the atmosphere and by rivers running over them. Hence their edges become revealed, and a variety of bars, as it were, of stratified rock run across the country, giving rise to very different types of soil. These beds of rock are obviously of various ages, those underlying a given bed having been laid down in earlier times, while those that overlie it are younger. Sometimes we find a series of strata resting on the worn-down edges of an older series, which was uptilted and denuded before the upper series was laid down. Between the two we have, then, an *unconformity*, and this lack of continuity may indicate an immense period of time, unrepresented at this point by any strata. This gap in our series may, however, be filled up by strata deposited elsewhere, and thus, by comparison of one area with another, we are able to build up a fairly continuous mass of sedimentary deposits stretching back from our own times to those of very high antiquity.

This sedimentary mass, which cannot be complete in any one district, owing to the frequent interchange of land and water areas, requires subdivision into *groups*, and still further into *systems*, which represent stretches of time styled respectively *eras* and *periods*. The strata of one limited district might be classified by their mineral nature and general structure, such as, to take an imaginary example, the Great Limestone system, followed by the Black Shale system, and so forth. But strata deposited simultaneously in other places might obviously have a completely different character, and stratigraphical geology must therefore use terms that are historical and of wide application. It was not until the close of the 18th century that William Smith, the English land surveyor and engineer, observed that successive strata contained characteristic animal remains. In his journeys by road across England, he was able to verify this conclusion over a sufficiently wide region; and similar work, undertaken in other countries, showed that the true principles of stratigraphical geology had now been discovered. Group after group of fossils was examined, and the animal types preserved in a stratum now enable us to assign it to its correct place in the long history of sedimentary deposits on the globe. Systems of strata have been established, like Murchison's old Silurian system, and these are characterized by their general faunas, although certain types of life may pass up from

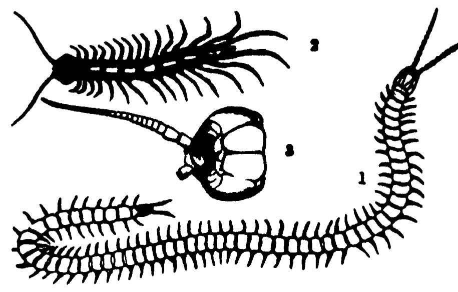
one system to another. Occasionally some animal form is limited to a particular 'zone', and species form in this way, far more than genera, indications of the 'horizon' on which a given stratum lies. Our geological maps, in countries where fossils are available, are consequently now historical rather than mineralogical. The broad band of Jurassic strata running across England may consist at one point mainly of limestone, at another mainly of clay; but at all points the occurrence of similar types of life mark the beds as belonging to the Jurassic period. The names of the systems generally adopted are founded on no rule. Some refer to places, some to the prevailing type of rock, some to the prevailing types of fossils occurring in them. They are arranged under four great groups, as follows, beginning with the oldest: I. *Archæan group*: systems indeterminate owing to want of fossils. II. *Palæozoic group*: CAMBRIAN, ORDOVICIAN (or LOWER SILURIAN), SILURIAN (or UPPER SILURIAN, or GOTLANDIAN), DEVONIAN, CARBONIFEROUS, PERMIAN. III. *Mesozoic group*: TRIASSIC, JURASSIC (including both LIASSIC and OOLITIC), CRETACEOUS. IV. *Cainozoic* (or *Tertiary*) *group*: EOCENE, OLIGOCENE, MIOCENE, PLIOCENE.

Most authors agree in beginning a fifth group, the *Quaternary*, with the POST-PLIOCENE (or PLEISTOCENE) system, and man himself may be regarded as living in the close of this very recent system.

The relative age of a system being thus established, attempts have been made to calculate the number of years, or thousands of years, occupied in its deposition. With such matters the present article need not deal. Immensely long as the past eras have been, the kinds of strata laid down in Cambrian times may be paralleled by those forming in existing lakes or seas. Even the Archæan sediments are merely much-altered representatives of our modern muds and sands and limestones. To the agriculturist, then, a stratigraphical map means but little, unless some well-marked type of rock, giving rise to a special soil, is known to prevail in the system under consideration. The articles on the stratigraphical systems in the present work therefore aim at describing the strata of the British Isles from the point of view of the student of rocks and soils rather than of fossil remains. It is important to know, however, on what basis the successive systems have come to be established.

[G. A. J. C.]

Geophilus longicornis (the Long-horned Centipede) is found, with *Lithobius forficatus* and other species, at the roots of turnips, &c.; indeed the earth is full of them, but they do more good than harm, by preying upon the larvæ of insects, &c. *G. longicornis*, like *G. electrica*, emits a phosphorescent light in the pairing season. It is yellow, with a rust-coloured head; antennæ three or four times as long as the head, hairy, and fourteen-jointed. Male with from fifty-one to fifty-three pairs of legs; female with fifty-four to fifty-seven pairs, and she lays from thirty to fifty eggs in a cluster, in a cavity in the earth, over which she nestles, and hatches them in two or three weeks. The natural length is 2 or 3 in. *Lithobius forficatus* is described in a special article. [J. C.] [F. V. T.]



1, *Geophilus longicornis* (Long-horned Centipede), magnified. 2, *Lithobius forficatus*. 3, Head of same magnified.

Geotrupes stercorarius, a large glossy violet-black beetle popularly called the Dor, Dor Beetle, Dumble-dor, Watchman, and Clock. The upper parts are black, the lower violet, and the elytra are deeply grooved. It flies with rapidity on warm evenings, making a droning sound. The female settles on a patch of cow dung, and then burrows through and under it to the depth of 1 ft. To the bottom of the hole she conveys a quantity of cow dung and lays an egg in it, and so on until all her eggs are laid, separated by layers of manure. All the Geotrupes are beneficial, not only acting as scavengers, but also helping the fertility of the soil by taking the manure into it, especially on grass land.

[F. V. T.]

Geranium.—Geranium or Crane's-bill is the name of a genus of dicotyledonous weeds frequently found among clovers and rye grasses. The common species are:—

1. Blue Meadow Geranium (*Geranium pratense*) of moist pastures. This is a downy perennial, with a short underground rootstock, and very large purplish-blue flowers about 1½ in. in diameter.

2. Jagged-leaved Geranium (*Geranium dissectum*) of dry pastures. This is a downy annual, with its leaves cut up into many fine segments, and bearing small red flowers about ¼ in. in diameter. When in fruit, the sepals are spread out round the hairy carpels.

3. Soft Geranium or Dove's-foot (*Geranium molle*), also in dry pastures. This is another downy annual, easily distinguished by the rounded leaf-blades from 1 to 2 in. in diameter, not cut up into fine segments, and by the small rose-coloured flowers. When in fruit, the sepals are spread out round the wrinkled (not hairy) carpels.

4. Stinking Geranium or Herb-robert (*Geranium Robertianum*), a common annual on hedge banks. The plant is distinguished by the disagreeable smell when bruised, and by the comparative baldness of the segmented leaves. When in fruit, the sepals do not spread out, but enclose and cover in the wrinkled carpels.

The seeds of Cut-leaved Geranium and of Dove's-foot are frequent impurities, particularly in Red clover and Alsike clover seeds. The seed of Cut-leaved Geranium, very common in Red

clover, has a purplish-brown colour. Its shape is broadly oval, 2 mm. by 1½ mm. The most characteristic feature is the honeycomb appearance of the skin, readily seen with the naked eye. The seed of Soft Geranium or Dove's-foot, common in Alsike clover, has a reddish-brown colour. Its shape is oblong, 2 mm. by 1 mm. The *smooth* skin without the depressions causing a honeycomb appearance, easily distinguishes this from the former species.

To prevent the spread of geraniums, seeding should be prevented, and the clover seeds sown out should be free from geranium impurity.

The Wild Geranium is not to be confused with the cultivated or garden Geranium, which belongs to the Pelargonium. See PELARGONIUM. [A. N. M'A.]

Geranium.—Parasitic Fungi. See PELARGONIUM, PARASITIC FUNGI.

Gerber Milk Tester, an apparatus for estimating the percentage of butter fat in milk. See BUTYROMETER and MILK TESTING.

Germ, the first stage in the life-history of an organism; the rudimentary or embryonic form of any living thing. Those minute organisms belonging to the plant kingdom which give rise to disease are commonly called germs.

Germinal Selection, a hypothetical process of struggle among the living units which compose a germ cell. It was suggested by August Weismann in 1895 that the familiar biological concepts of 'struggle' and 'selection' might be extended to the individual items which compose the germ plasm—*i.e.* the inheritance. If we suppose, as there are many reasons for supposing, that the physical basis of inheritance in the germ cells is composed of a multitude of representative vital particles which are able to feed, grow, and multiply, then it is conceivable that fluctuations in the nutritive supply of the germ cells and inequalities in the vigour and assimilating power of the hereditary constituents may result in an intra-germinal struggle and selection. According to Weismann, who elaborated this general idea into a very ingenious theory, germinal selection helps us to understand the dwindling away of organs which have passed below the level touched by ordinary natural selection, the occasional exaggeration of organs beyond the limits of demonstrable utility, *e.g.* the 6-ft.-long tail feathers of some Japanese cocks, the occurrence of definitely directed, appropriate, and simultaneous variations, and much more besides. The theory of germinal selection is, of course, a hypothesis, dealing with the invisible, but it may be none the less useful if it enables us provisionally to formulate a number of very puzzling facts, and if it suggests experimental work, on which, eventually, we must base our conclusions as to these abstruse questions. [J. A. T.]

Germination, *i.e.* the process of development of the embryo-plant from the seed, may

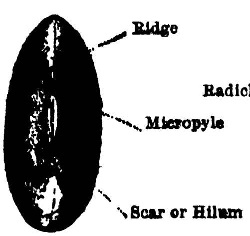


Fig. 1.—Seed of Scarlet Runner, external view

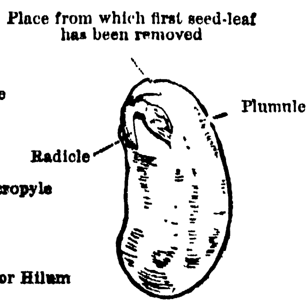


Fig. 2.—Seed of Scarlet Runner, one cotyledon removed

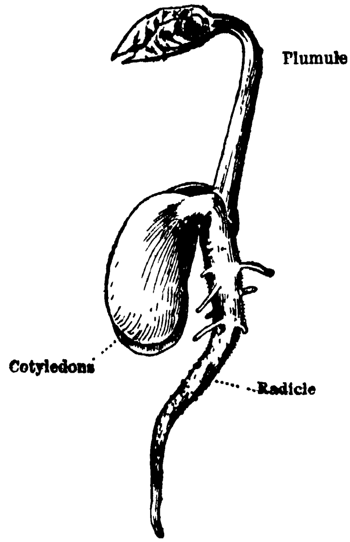


Fig 3.—Germinating Bean

be regarded as the first stage in the new life-cycle of the plant-individual. It is separated from the life-cycle of the mother-plant by the dormant period, through which the seed passes prior to germination. As a general rule, seeds are not capable of immediate germination, although exceptions are afforded by the seeds of most ephemeral plants. The resting period is not generally of long duration, its length being dependent on the external conditions; the seeds of some Conifers, however, will only germinate after several years. Certain plants (*e.g.* Red Clover, False Acacia) produce two kinds of seeds, the one kind being capable of immediate germination, the other having to pass through a prolonged resting period. The seeds of most plants, however, are able to retain the power of germination for a considerable length of time, although in many cases they lose in vigour if germination is delayed very long. The seeds of cereals seem to retain the power of germination only for about ten years, while those of leguminous plants can last much longer; on the other hand, seeds which are rich in ferments, and those in which the reserve-products are of a fatty nature, quickly lose the power of germinating.—Germination depends on the realization of certain external conditions, the most important of which is the presence of sufficient moisture, heat, and oxygen. Moisture is required

primarily to initiate the processes of growth in the embryo which lead to its emerging from the seed-coat; but in many seeds (especially in seeds with a mucilaginous envelope) it is also eagerly absorbed by the seed-coat itself, leading to the softening and swelling of the latter. Most of the water enters the seed by way of the micropyle or any other apertures that may be present, and frequently there are special absorptive systems developed in connection with these apertures (*e.g.* the caruncle of the castor-oil seed, and the complicated system within the walnut); where the seedcoat is not too thick, however, a small and variable amount of water also passes directly through it to the interior of the seed. The water absorbed by the embryo (or in some cases the endosperm), and the consequent increase in size of the latter, generally lead to the rupture of the seed-coat, except where the latter is very thick and hard; in the latter case there are often special apertures (or soft portions of the seed-coat), through which the embryo emerges (coconut). There is no doubt that in many cases the seed-coats constitute a hindrance to germination, and they are frequently cracked or otherwise artificially opened before the seeds are planted. Acacia seeds are frequently boiled for a few minutes, whereby the seed-coats are softened and rendered more readily permeable to water; such boiled seeds germinate in a much shorter space of time. Germination further depends on the realization of a certain minimum temperature, which varies very considerably in different types of plants, and is no doubt to some extent dependent on the other conditions influencing germination. According to Haberlandt, the minimum lies between 0° and 4·8° C. in the case of hemp, oats, wheat, barley, pea, &c.; between 4·8° and 10·5 C. in the case of the maize; between 10·5° and 15·6° C. in the pumpkin and tobacco; and between 15·6° and 18·5° C. in the melon and cucumber. At the minimum temperature, germination only takes place very slowly, and the rapidity with which the process goes on increases steadily from the minimum up to a certain (optimum) temperature. Another important condition for germination is the presence of a sufficient amount of oxygen, since the process of respiration is particularly active at this time; hence the importance of not planting seeds at too great a depth, as the deeper layers of the soil as a general rule contain more water and less air than the surface layers. Fatty seeds require more oxygen during germination than seeds containing other kinds of food materials, as some of the oxygen is in this case utilized in oxidizing the fats and oils. There are other conditions affecting germination, which are not so important. Most seeds germinate best in the absence of light, but the spores of many ferns and the seeds of a few of the higher plants require light for germination. The seeds of some parasites (*e.g.* the Broom-rape) only germinate in the presence of a suitable host plant.

The actual process of germination is initiated by growth-processes within the embryo (or in some cases the endosperm). The radicle is situated in the immediate neighbourhood of the micropyle, and is thus best supplied with moisture, and is very frequently the first part of the young plant to emerge from the seed-coat. In many monocotyledonous seeds, however, the cotyledon is the first to emerge, and is also often in large part responsible for the first rupture of the seed-coat. The further stages in the process of germination show infinite variety. As a rule, the radicle becomes firmly established by means of lateral roots and root hairs before the other parts of the embryo begin to grow actively. The plumule is drawn out of the seed in various ways, most commonly by elongation of the stalks of the cotyledons or growth of the hypocotyl. The cotyledons may either remain within the seed (hypogeal), or be carried up above the soil (epigeal) as the first pair of foliage leaves; the former is frequently the case when the cotyledons are themselves crowded with food-materials (bean, acorn), or when they serve the purpose of absorbing food-materials from the endosperm (*e.g.* in grasses). [F. E. F.]

Germ Meal.—This term is generally applied to a product of maize, but it may also apply to wheat. In either case the 'germ', or embryo, of the grain is removed from the more starchy portion and is used separately, after grinding, as a feeding material. The removal of the germ is effected by the new process of 'roller' milling. The principal differences between maize germ meal and maize itself consist in the former being considerably richer in oil and in nitrogenous matters, and correspondingly lower in starchy bodies. Variations will occur in the quality, too, according as the meal contains more or less of the whole grain mixed with it, and it sometimes happens that the term 'germ meal' is given to what is really little better than maize meal. Properly prepared, however, maize germ meal has approximately the following composition:—

Moisture	13·21
Oil	6·75
[1] Albuminous compounds	22·27
Starch, sugar, digestible fibre, &c.	50·44
Woody fibre	3·73
Mineral matter (ash)	3·60
	100·00

[1] Containing nitrogen ... ... 3·56

Occasionally samples will be met with giving more oil than the above, even up to 10 or 12 per cent. These samples are, however, considerably lower in nitrogen. Germ meal should be quite free of sand. It has a sweetish taste, and is in considerable request, chiefly as a food for milking cows, more especially where butter is made. A cake is sometimes made of the meal and called 'maize germ cake', but analyses of this show it to be generally poorer in oil and in albuminous matters than the germ meal. The germ of wheat is similarly removed and used as a food, though not nearly so frequently as is the case with maize. [J. A. V.]

Germ Plasm. — The essential formative material of the germ cells is called the germ plasm. It is the architectural substance, the

vehicle of the heritable qualities. Everyone admits that the physical basis of inheritance is to be found in the egg cells and sperm cells, which, in spite of their minuteness, do in some way contain all the hereditary qualities. But the whole of the germ cell is not equally important; thus the yolk of the egg is obviously nutritive not formative, and the tail of the spermatozoon is a quite accessory locomotor structure. Various considerations, *e.g.* that the number of chromosomes (stainable bodies in the nucleus) is definite for each species, that spermatozoon and ovum have an equal number of chromosomes, that there is a very exact partition of paternal and maternal chromosomes among the cells into which the fertilized ovum develops, led Weismann to conclude in 1885, as Strasburger and O. Hertwig did about the same time, that the essential hereditary substance or germ plasm is in the chromosomes of the nucleus of the germ cells. (Compare the art. BREEDING, LAWS OF.) There are some authorities, however, who maintain that the most essential hereditary substance is not in the readily stainable chromosomes, but in the more delicate bands of linin which bear the chromosomes within the nucleus. Others, again, hold that in a complex body like a cell it is unjustifiable to abstract one part of the protoplasm from the rest. The cell, in spite of its minuteness, is a unified organization. Of great importance and interest is Weismann's conception of the continuity of the germ plasm (1885), which may be briefly stated in his own words: 'In each development a portion of the specific germ plasm, which the parental ovum contains, is not used up in the formation of the offspring, but is reserved unchanged for the formation of the germinal cells of the following generation'. . . . 'The splitting up of the substance of the ovum into a somatic part, which directs the development of the individual, and a propagative part, which reaches the germ cells and there remains inactive, and later gives rise to the succeeding generation, constitutes the theory of the continuity of the germ plasm.' See HEREDITY, OVUM, SPERMATOZOON. [J. A. T.]

Géromé Cheese.—There are two kinds of cheese made in the mountainous region of the Vosges, the one in France, the other in German territory. These cheeses differ more in nomenclature than in character. Both are what is called 'hard' cheese, to differentiate them from the 'soft' kinds of cheese which predominate so largely in France and Germany. The French variety is named Géromé (an adaptation from Gérardmer, a village in the region where the cheese is made), and the German, Münster. In the making of Géromé cheese, cows' milk, not skimmed, and sometimes a little goats' milk, is used. The milk, coagulated at a temperature of 80° to 90° F., is ready in half an hour for cutting into cubes, after which the whey at once begins to disentangle itself from the curd, and is removed about an hour later. The curd is then put into hoops of 6 or 7 in. diameter, wherein it becomes a solid and shapely cheese. Turned twice daily, and each time into fresh hoops, they are salted on the outside, in a room at about 70° F. Salting having been finished, the cheeses are put into a well-ventilated room, and when sufficiently dry are taken to the curing cellar. Ripening requires from six to sixteen weeks, depending on the sizes of the cheese, which vary in weight from ½ lb. to 5 lb. or more. Anise or caraway seeds are sometimes mixed with the curd, but such adventitious flavours in cheese are very properly dying out. [J. P. S.]

Gervais Cheese.—This is a French cheese, and one of the richest of cheeses when made as it should be, approximating to a Stilton similarly made, and even to a cream cheese in what is understood as 'quality', viz. richness in butter fat. It is made from new fresh milk, 'which is enriched by the one half of its volume in cream'. This is the formula of the raw material, given on authority, and a specially rich cheese must issue from it if the process of making is well carried out. The milk and cream are well stirred for a few minutes, in order that the added cream may be thoroughly incorporated with the new milk. In the use of cream a day old there is merit of some not inconsiderable consequence, inasmuch as it has presumably—almost certainly—become impregnated with the lactic acid bacillus during the twenty-four hours, and communicates this necessary ferment to the new milk. The milk is renneted with ½ c.c. at a temperature of 60° to 65° F. as the weather outside may be warm or cool. If set in the evening the coagulum is ready for ladling out into suitable cloths when morning comes. Two quarts of milk and one of cream will yield a dozen cheeses, whose dimensions are 2¼ in. by 1¾ in. They are in the category of soft cheeses and are chiefly eaten fresh, but, like cream cheeses, are all the more toothsome if kept until the lactic ferment has gone some way in ripening them. [J. P. S.]

Gessenay Goat, a white Alpine variety met with in the Gessenay district of Switzerland. This is practically the same breed as the Saanen (see GOATS, BREEDS OF), only smaller. A few specimens have been imported into England and crossed with the Toggenburg. [H. S. H. P.]

Gestation, the period of development within the mammalian uterus. To begin with, the developing ovum is attached to the uterine wall by very delicate outgrowths from its outermost layer (the preliminary villi of the *trophoblast*). These have a nutritive as well as a fixing function. In the second place, in many mammals, such as rabbit, hedgehog, and horse, there is a provisional yolk-sac placenta. In other words, attaching and absorbing villi grow out from part of the wall of the *yolk-sac* into the wall of the uterus, carrying before them as they grow the subzonal membrane or chorion and the trophoblast. In most of the marsupials this is the only placenta. In the third place, there is the true or allantoic placenta. In this case, vascular villi grow out from the wall of the *allantois* into the modified wall of the uterus, carrying before them as they grow the subzonal membrane or chorion and the trophoblast. In many cases the allantoic placenta is the only one developed, and it is always of supreme importance in reference to the nutrition of the embryo. There is an interlocking of

the fœtal villi and the maternal tissue, and the maternal blood in the spaces of the spongy outer layer of the uterine mucous membrane bathes the trophoblast covering the villi. By the activity of the trophoblast cells the nutritive and respiratory advantages of the maternal blood are secured for the embryo's blood which circulates in the villi. There is a passage of fluids and gases from the mother to the offspring and conversely. A passage of microbes may also occur from mother to offspring, sometimes bringing about antenatal infection. In some cases (carnivores) there seem to be normal extravasations of maternal blood, which are absorbed by the placental villi. There is sometimes (*e.g.* in ruminants and carnivores) what has been called 'uterine milk'—an albuminoid fluid due to degeneration of uterine epithelium—with which leucocytes may be mixed, and it is believed that this has some nutritive significance in very early stages. To sum up: in various ways, of which the true placenta is the culmination, the developing embryo is attached to the modified wall of the uterus; the embryo gets food and oxygen, and gets rid of its waste products by what may be called vital diffusion between its blood and that of the mother. During the period of gestation the embryo or fœtus lives like an internal parasite on the mother, but the connection between the two is far more subtle. There is a 'mysterious wireless telegraphy of antenatal life'.

The length of the gestation differs greatly in different kinds of mammals, and varies slightly even in the same species. In a general way it may be said that the period is longer in the more differentiated types than in the less differentiated. In types about the same level of differentiation it tends to be longer in the larger forms. The period tends to be shorter when the number of offspring born at a time is large. The following statement of the average gestation in days for a number of types is taken from a very valuable study by Dr. John Beard (The Span of Gestation and the Cause of Birth, 1897):—

	Days.
Horse	336
Cow	280-287
Man	276-280
Sheep	145-150
Pig	112-120
Guinea-pig	63-66
Dog	58-64
Cat	56
Kangaroo	38
Rabbit	30½-31
White mouse	19½-19⅘
Opossum	7¾

There can be no doubt that the length of the gestation is regulated in relation to the general rhythm of reproduction, being adjusted to ovulation on the one side and lactation on the other. A very ingenious and interesting theory of this adjustment will be found in Beard's essay.

[J. A. T.]

Geum.—Geum, commonly called Avens, is a genus of perennial rosaceous herbs, easily recognized by the apparently double calyx of ten sepals, and by the fruit, composed of achenes each with a long, jointed and hooked awn (style). Two species are common: (1) Wood Avens, or Herb Bennet (*Geum urbanum*), on hedge banks. This is distinguished by the yellow erect flowers about ½ in. in diameter, and when in fruit by the bald upper joint of the awn from the achene. (2) Water Avens (*Geum rivale*), in moist pastures by the sides of streams. Here the flower is drooping, the orange petals are covered by the purple calyx, and the whole flower is large, exceeding 1 in. in diameter. When in fruit, the upper joint of the awn is feathered and not bald.

[A. N. M'A.]

Several of the Geums are cultivated as hardy border plants, as they grow well in ordinary soil, forming nice masses of foliage and red or yellow flowers. Others are grown in the rock garden, as they are dwarf and tufted. The best are: *G. chiloense*, a Chilian species which grows 2 ft. high and has bright-scarlet flowers; also several garden varieties of it, such as *miniatum*, *grandiflorum*, &c. *G. montanum*, a European plant, forms a compact plant about a foot high, and has bright-yellow flowers. The plants are easily propagated by division or from seeds.

[W. W.]

Ghost Flies, a genus of small hemipterous insects, snowy-white in colour. See ALEYRODES.

Giant Wood Wasp, a large hymenopterous insect, the larva of which does considerable damage to timber. See SIREX GIGAS.

Gid, Sturdy, or **Turnsick.**—This disease in sheep is caused by the hydatid or bladder form of tapeworm (*Cœnurus cerebralis*), which by its pressure upon the brain induces fits, during which the animal depresses its head to one side, and often spins round in one direction until it falls; recovering in a few minutes as a rule, and resuming grazing. The situation of the bladder makes any operative interference extremely dangerous; but some bold shepherds insert a wire up the nostrils, and occasionally succeed in breaking up the cyst without inflicting mortal injury on the host. Such a practice can scarcely be recommended, as the half-fat sheep will probably be finished for the butcher without a fatal termination. Preventive measures should be considered, such as the periodical physicking of dogs bearing the tapeworms, and the salting and sooting of land where gid is known to occur. In the case of a valuable pedigree animal, it may be worth while to trephine the skull and break up the bladder.

[H. L.]

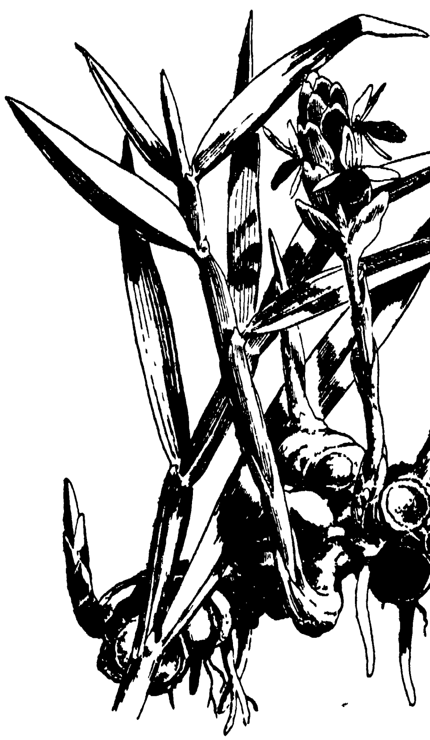
Gilbert, Sir Joseph Henry, Ph.D., M.A., LL.D., Sc.D., F.R.S.—This distinguished agricultural chemist was born at Hull in 1817. On the completion of his school education he proceeded to the University of Glasgow, where he gave special attention to chemistry, working in the laboratory of Professor Thomas Thomson. Afterwards he studied at University College, London, where he worked in the laboratory of Dr. A. T. Thompson, one of his fellow students being John Bennet Lawes. Later on he studied for a short time in the laboratory of Liebig at the University of Giessen, where Lyon Playfair and Augustus Voelcker were his fellow students. While at Giessen he took the degree

of Ph.D. Returning to England, Gilbert became, for a short time, class and laboratory assistant to Dr. A. T. Thompson, under whom he had previously studied at University College, London. In 1843 he commenced his long association with John Bennet Lawes by accepting the position of coadjutor and technical adviser to that gentleman, who had just started his experimental farm on his estate at Rothamsted. This association lasted until the death of Sir John Lawes in 1900, and all the world knows how fruitful in valuable work on behalf of agriculture it was. It was an association of cordial friendship as well as of work, unbroken for fifty-four years, after which death alone dissolved it. In an appreciative memoir contributed to the Journal of the Royal Agricultural Society in 1901, from which details of his life are taken, Dr. J. A. Voelcker attributes much of the value of the Rothamsted experiments to Gilbert. If Lawes was the more fertile in initiative, he states, Gilbert was pre-eminent for indomitable perseverance, and it was to the latter mainly that the continuity of the experiments was due. His scientific knowledge, precision, and indefatigable attention to details, moreover, were invaluable for the work and its records. But Dr. J. A. Voelcker is careful to point out that what was Lawes' work was Gilbert's work. 'The two', he says, 'are indissolubly connected, and as we retain the memory of the two together, so we shall retain their works. Together Lawes and Gilbert will go down to posterity as the name of a combination unique in the influence which it had upon the agriculture of the 19th century, and on agricultural science in particular.' Together they wrote nearly all the numerous reports and articles descriptive of the experiments and their results. In July, 1893, when the jubilee of the collaboration of the two famous men was celebrated at Rothamsted, Gilbert was presented with a silver salver and addresses from many distinguished bodies, and in August of the same year he was knighted by Queen Victoria. He became president of the Chemical Society in 1882, and he was a Fellow or member of other learned bodies, including the Royal, the Linnean, and Royal Meteorological societies. In 1883 he was elected an honorary member of the Royal Agricultural Society. In 1884 he became Sibthorpian Professor of Rural Economy at Oxford University. He was also elected an honorary professor of the Royal Agricultural College, Cirencester, and he received honorary degrees from the universities of Glasgow, Oxford, Edinburgh, and Cambridge; while he was honorary corresponding member of several foreign agricultural and scientific societies. In connection with several of his positions he delivered lectures on science or on the Rothamsted experiments, including lectures in the United States on behalf of the Lawes Agricultural Trust, after it had been founded to perpetuate the work which he and Sir John Lawes had so long carried on. Working on to the last, even after his health had failed, Sir J. H. Gilbert died on December 23, 1901, in his eighty-fifth year, not much more than a year after his distinguished colleague. [W. E. B.]

Gilt, a young female pig or sow.

Gimmer.—The female sheep before bearing its first lamb is called a gimmer in Scotland and northern England. An English equivalent is *theave*, or *threave*.

Ginger (*Zingiber officinale*, nat. ord. Scitamineæ), a plant which seems to be a native of south-east Asia, but is now cultivated in most tropical countries, such as portions of China,



The Ginger Plant—showing Rhizome

India, Malaya, South America, the West Indies (Jamaica), and Africa (Sierra Leone), where not too hot nor too moist. It requires a rich sandy loam, with perfect drainage. Although often raised near the seashore, it is most successfully cultivated at from 1000 to 5000 ft. in altitude. The seasons of planting and harvesting depend greatly on the climate and the season of rainfall. It is propagated by sets prepared from last year's rhizomes (*races* as they are called in the trade), each having at least one bud, and the cuttings are at once placed in their permanent positions. The land is thoroughly and carefully prepared and cleared of weeds, then thrown up in ridges 2 or 3 ft. apart, and, where necessary, water channels are dug through and around the plot. In February to April, holes

are opened along the ridges about 1 ft. apart, a fair quantity of well-rotted leaf mould and farmyard manure is added to each, and the sets then covered over to a depth of 3 to 4 in. About August or September the surface is topdressed with manure, oilcake being often specially given. The field is also frequently hoed and weeded, and should the rain fail, irrigation may have to be given once or twice a month. By October or November the crop begins to come into season, and is fully ripe by February to March. Under high-class cultivation a yield of 4000 lb. of rhizomes to the acre may be obtained.

The rhizomes are dug up, washed, then plunged into boiling hot water for a few minutes, and thereafter dried in the sun; or after washing they may be scraped till the black outer skin is removed, then dried. The former is known as 'unscraped', 'coated', or 'black' ginger, and the latter as 'scraped' or 'white' ginger. It is largely imported into Great Britain both in its dried and bleached state, as also after having been preserved in syrup or sugar. The finest qualities of scraped ginger come from Jamaica, and of the preserved rhizome from China. The imports of the dried root have averaged about 59,000 cwt. during the past five years, contributed by India (32,000), Africa (10,000), the West Indies (10,000), and foreign countries (6000). Of preserved ginger, about 40,000 cwt. are annually imported by Great Britain, nearly the whole coming from Hong-Kong. [G. W.]

Gingko, or **Japanese Maidenhair Tree** (*Gingko biloba*), is the only species in the Gingko genus of the Salisburineæ sub-tribe of the Taxaceæ tribe of the Coniferæ (see CONIFERS), and is the sole known survivor among the many fern-leaved kinds of trees common all over the world in previous geological periods. It is easily distinguishable from all other trees by its smooth, light-green, leathery, fan-shaped, two-lobed deciduous leaves growing in bunches of three to five on short alternate spurs, and somewhat resembling magnified leaflets of the maidenhair fern. These give it a distinctly quaint rather than a really beautiful appearance, though during the short time that its autumn tint lasts before the foliage is shed, its rich golden colour contrasts well with the browner hues of most of our other ornamental trees. It does well in the London parks, as its tough, leathery leaves seem capable of resisting fairly well the injurious effect of town smoke. But even in the Far East, whence it was introduced into Britain about 1754, it is purely an ornamental tree, for (besides producing only soft and brittle yellowish wood) it is cultivated as a sacred tree near temples and shrines in China and Japan, though said to be found growing wild in Korea. In the Far East it attains up to nearly 100 ft. in height and up to about 20 ft. in girth. Its drupelike fruit has a sarcous greenish-orange covering over the nut containing the seed, and the nuts are eaten as a dessert fruit by the Japanese; but to western ideas the fleshy part smells objectionable, and the nut has an unpleasant taste. It only grows well in the warmer parts of Britain, and does best on a deep, fresh, loamy soil, and in a mild and sheltered position. As apparently only male specimens were originally introduced into Britain, fruit is only produced when cuttings from female trees are grafted on them. Most of our present trees have been raised from slips or from layers, and three common varieties (*macrophylla*, *pendula*, and *variegata*) are also cultivated from cuttings. [J. N.]

Ginseng (*Aralia quinquefolia* var. *ginseng*, nat. ord. Araliaceæ) is a native of North China, Manchuria, Mongolia, &c. It is a low perennial herb with forked conical roots. These are highly valued in China, being viewed as a potent restorative for exhausted animal powers, making old people young again,—is, in fact, accepted as a panacea to ward off practically all the ailments of mankind. The finer qualities are obtained from Korea and realize extravagant prices. American *ginseng* (derived from another variety of the same species) is conveyed to China and sold as a substitute or inferior grade. *Aralia pseudo-ginseng* — a native of Nepal, Sikkim, Bhutan, and the Khasia hills—is considered by botanists as doubtfully distinct from the Chinese plant; it has no medicinal properties assigned to it in India. According to European investigations and experience, the *ginseng* is simply mucilaginous, aromatic, bitter, and saccharine, but possesses little or nothing to justify its Chinese reputation. [G. W.]

Gipsy Moth, a brownish-coloured moth which does much damage to fruit and forest trees. See ORYGIA.

Girdling.—This operation, which is also termed 'ringing', consists in removing a narrow ring of bark from a branch or stem of a tree, the theory being that fruitfulness is induced by preventing the downward flow of sap. It is generally done just before the opening of the flowers. In our opinion it should only be resorted to in the case of fruit trees that are persistently barren. It is little practised in this country, but some of the American fruit growers have great faith in it. [W. W.]

Girth, the circumference of the stem of a tree; the measurement round the body or waist; the bellyband of a saddle.

Glacial Drift. See DRIFT.

Glacial Epoch.—About the time that man began to spread, probably from Asia, over the habitable earth, the lands that he encountered had just been profoundly modified by climatic changes of a very serious nature. The Glacial Epoch had, in fact, only just come to an end, and in many areas large masses of ice still occupied the lowlands, and rivers flowed from their melting edges, bearing their burden of detritus this way and that across the plains. The deposits left on the retreat of the ice have been discussed under the article on DRIFT; and there is now no doubt that the period of damp and cold known as the Glacial Epoch prevailed both in the northern and southern hemispheres, and arose from some unknown cause that affected the globe as a whole. Whether the cause is to be looked for in variations in the sun's heat, in changes in the form of the earth's orbit, in a reduction in the amount of carbon dioxide present in the atmosphere, or in any other hypothesis,

we have to face the fact that a similar ice age, leaving traces far nearer the Equator, occurred in Permian times, and further, that considerable extensions of ice took place in pre-Cambrian epochs, probably affecting very wide areas simultaneously. The Glacial Epoch best known to us, however, is that which set in at the close of Pliocene times. Great Britain was invaded on the east by ice that stretched across from Scandinavia, a corresponding invasion from the same northerly centre spreading over Finland and down into North Germany as far as Dresden. The heavy snowfall in the Grampian region led to glaciers that pressed down on Ireland and occupied the Irish Sea. Local ice at the same time covered almost the whole of Ireland. Huge deposits of drift were left in the hollows of the older surface of Europe when the ice melted. The Prussian plain, with its enormous level fields, and the sandy hillocks of northern Holland, are thus formed of material from Scandinavia, while the great plain of southern Bavaria and much of that of northern Italy result from drift brought down by vast extensions of existing Alpine glaciers and by later glacial floods. Even in Turkestan and on the east flanks of the Andes, similar flood gravels have been traced in connection with this epoch of copious rainfall and snowfall. The soils, then, on which we live, and those encountered by the first tillage farmers of prehistoric days, would have been far more localized and sharply divided into sterile and fertile types, were it not for the mingling and distributing agents connected with our latest Glacial Epoch. [G. A. J. C.]

Glades are openings in woodlands formed by roads or paths for the purpose of giving long vistas, or for battue-shooting, or for convenience in extracting timber and in general management. Where the continuous canopy of the woodland trees is thus in any way interrupted either naturally or artificially, the converging boughs assume a definite shape, varying from the pointed outline of a Gothic arch to the round Norman arch. And this casual similarity has given rise to the fanciful and quaint suggestion that glades in beech and oak woods perhaps furnished the ideas for the special forms in which the Gothic and the Norman arches were built. When any fresh clearance is made in cutting glades through woodlands, the soil usually soon gets overgrown with coarse grasses and wild plants. But a finer growth can easily be obtained by sowing, after the soil has been levelled and firmed down, a mixture of grass seeds in about the following proportions by weight: 4 lb. of wood meadow, 2 lb. each of smooth-stalked meadow, rough-stalked meadow, rough cocksfoot, and sweet-scented vernal, and 1 lb. each of timothy, hard fescue, tall fescue, and meadow foxtail. For sandy or gravelly soil, however, sowing with a mixture of equal parts of sea-marram and lyme-grass seed answers best. [J. N.]

Gladiolus (Corn Flag), a genus of Irideæ comprising about ninety species, natives of Central and Southern Europe, West Asia, and Africa, particularly South Africa. The flowers are borne on tall scapes, and comprise a variety of colours; the leaves are sword-shaped, and the corms have netted fibrous coats. Generally speaking, the species have been superseded by the numerous fine hybrid forms which began to make their appearance about sixty years ago, and continue to be produced in large numbers. A favourite flower here, the Gladiolus may be said to be even more esteemed on the Continent and in America, but this country possesses some eminent specialists. Its peculiar value is for late summer and autumn garden effects, but varieties of the early flowering Colvillei group are extensively grown under glass to provide flowers in the spring. Many people think that gladioli are somewhat ungainly in appearance when grown alone, but this may be obviated by placing them among low-growing shrubs or by using mignonette, &c., as a groundwork, and they are universally admired as cut flowers. A deep rich soil is the best, but fresh manure is prejudicial. Planting should commence in March, and may be continued at intervals until the end of May to provide a successional display. Insert the corms 3 in. deep, and 1 ft. apart, if in beds, for the more vigorous kinds. Water plentifully in a dry season, and a mulch is also beneficial. The corms should be lifted before severe frosts occur, and kept in paper bags till planting time after the tops have dried off. The large-flowered sorts are also very suitable for summer flowering in pots in the greenhouse. The best hybrids, comprising the Colvillei, Gandavensis, Nancyanus, and Lemoinei groups, have been raised from *G. cardinalis*, *G. communis*, *G. psittacinus*, *G. oppositiflorus*, *G. purpureo-auratus*, and some others. [W. W.]

Glanders and Farcy.—Glanders and farcy are different names applied to the same disease, the first covering those cases in which there are no skin lesions, and the second those in which skin lesions are present.

Cause of the Disease.—Glanders is a disease which modern research has proved to be caused by a microbe or bacterium, named the *bacillus mallei* or *glanders bacillus*. This bacillus is constantly present in the lesions and the discharges from them, and the spread of the disease is due to the transference of the bacilli from glandered to healthy horses. Although the bacillus can be cultivated in artificial media outside the body, there is no reason to believe that in natural circumstances it ever multiplies to any extent except in the bodies of affected animals, or that glanders ever arises in any other way than by contagion. Long after experience had proved that glanders was contagious, it was very generally held that it could also originate in other ways, this belief being founded on the observation that on board ship and in camps it often broke out among horses which, so far as was known, had never had any connection with glandered horses. The fact that, even at the present day, glanders frequently attacks horses that have never been in contact with visibly diseased animals has to be admitted, but this in no way compels one to admit that it ever arises sporadically, for it is now known that it is no uncommon occurrence for a horse

FARCY

to be glandered although he presents no outward indication that he is diseased.

Susceptibility of Different Animals.—Although other animals than horses are capable of contracting the disease, glanders is essentially an equine malady. There can be no doubt that if the horse were to become an extinct species the glanders bacillus would perish with him. Broadly speaking, the normal mode of existence of the glanders bacillus is to multiply in the bodies of diseased horses, and to perpetuate its species by means of those individual microbes which escape with the discharges, and, re-entering healthy horses, start the disease in them. Occasionally, and, so to speak, accidentally, such escaping bacilli are introduced into the systems of other animals than horses, with the result that they become the victims of glanders. In this way human beings not rarely contract the disease, and in like manner it has sometimes been transmitted from horses to cats and goats. In all such cases, however, the disease usually comes to an end with the death of the first victim, since it is only among horses, asses, and mules that it becomes markedly contagious.

Methods of Infection.—The question as to what is the common natural method of infection in glanders has been much disputed, and even now opinion is not quite unanimous on the subject. As throwing some light on the matter, it may be mentioned that, experimentally, glanders can be transmitted with deadly certainty to horses or other susceptible animals by inoculation—that is to say, by rubbing the bacilli into a wound or injecting them under the skin. Provided a large dose of bacilli be employed for the experiment, the disease can also be transmitted by causing horses to swallow the infective material. These facts would appear to render it *a priori* probable that inoculation and ingestion must play at least some part in the natural spread of the disease, for, given a badly infected stable, some contamination of food or water must take place, and infective materials must sometimes gain access to open wounds. That some cases are due to such wound infection has always been admitted, but the main point of dispute has been whether horses are more frequently infected by swallowing infective matters or by inhaling them. In reality the interest of this question is academic rather than practical, but it may be said that during recent years nearly all authorities have adopted the view that ingestion of water or food contaminated with discharges from diseased animals is the common way in which glanders spreads from horse to horse. It is not impossible that this is also the common way in which human beings contract the disease, though it is generally believed that human infection more frequently results from the application of infective materials to the nose or to a wound or abrasion of the skin.

In the preceding paragraph the words 'infective materials' have more than once been used, and it will be understood from what was previously stated that what renders any material infective is the presence of living glanders bacilli in it. In natural circumstances the source or fountain-head of the bacilli is the already infected horses, from the bodies of which the bacilli may at any time escape. There is no doubt that the main channel by which bacilli escape from a glandered horse is the nose, and next after that the diseased skin in cases of farcy. A glandered horse with a visible discharge from his nostrils or with running farcy sores is a tremendous source of danger in a stable. It ought, however, to be emphasized that a glandered horse may spread the disease to others although he is not affected with farcy and has no visible discharge from his nose. It is also certain that the bacilli sometimes leave the body of a glandered horse with the fæces or urine.

Symptoms and Course of the Disease.—Until comparatively recent times an opinion universally held regarding glanders was that in the great majority of cases it ran a rapid course and inevitably caused death. Modern experience has proved beyond any doubt that this estimate of the gravity of glanders as a disease of the horse was wrong. In the great majority of cases of glanders occurring among horses that are well fed and not overworked the disease runs a mild course, and it is only in the minority that it progresses rapidly and threatens the animal's life. In a considerable proportion of cases the disease remains occult (that is to say, not manifested by any outward symptom or evidence of ill-health) for months or years, and there is good reason to believe that in not a few cases the animal eventually makes a complete recovery.

In some cases the disease becomes 'clinical' within a few weeks or months after infection, and it is important to remember that at any moment the slumbering or latent disease may be wakened up, with the result that its further course is rapid and fatal if not cut short by slaughter.

Keeping in mind what has just been said as to the absence of any sign of ill-health in many cases of glanders, the following may be regarded as the ordinary symptoms of the disease. Not rarely the earliest symptom is a certain amount of loss of condition, or unthriftiness, in spite of the fact that the food is sufficient and the work not excessive. Subsequently the animal may begin to run at one or both nostrils, and the glands between his jaws begin to enlarge. In many cases this glandular enlargement sets in although there is no visible or excessive discharge from the nose. The swollen glands feel firm and nodulated, and they rarely burst or discharge pus. With little or no variation, this glandular enlargement may persist for months, and the horse may not appear to be very seriously ill, but suddenly or gradually the nasal discharge may become more abundant or streaked with blood, and examination of the nose may reveal the presence of ulcers on its lining membrane. To these symptoms those of farcy may be added, in which case small nodules or 'buds' form under the skin, burst, and discharge a thick oily-looking matter. Those buds may develop on any part of the skin, but the favourite seat is the hind limbs, which are often at the same time generally swollen.

Lesions.—Besides the structural alterations or lesions already mentioned, there are others which involve the internal organs and are therefore only seen on post-mortem examination. These internal lesions take the form of nodules, and by far the commonest seat of them is the lungs. In that position nodules are almost constantly found at the post-mortem examination of glandered horses, no matter whether the disease at the time of slaughter was 'occult' or 'clinical'. Experience gained in slaughtering out infected studs indicates that as a rule the earliest lesions are in the lungs, and in the mild non-fatal cases the disease may for a long period be confined to these organs, or to them and the attached lymphatic glands. These glanders nodules are very variable both in size and number. Ordinarily most of them are about the size of a pea, and their number does not exceed a few dozen or scores, but exceptionally there may be hundreds of them.

A somewhat remarkable fact is that although it is now generally supposed that the bacilli which start the disease are absorbed from the intestine, post-mortem examination often reveals no lesions within the abdomen. Sometimes, however, nodules are present in the spleen or liver.

Diagnosis.—Under the Contagious Diseases (Animals) Acts it is the duty of horse-owners to suspect glanders when a horse exhibits the symptoms usually associated with that disease. That, of course, does not imply that the accurate diagnosis of glanders is within the ability of an ordinary layman. As a matter of fact, the diagnosis of the disease is often a matter of difficulty even to the experienced veterinary surgeon, though the introduction of mallein (which is a liquid culture freed from the glanders bacilli by heat and filtration—see MALLEIN TEST) has immensely simplified the task when the suspected animal is alive, and bacteriological methods when properly applied post-mortem will nearly always conduct to a correct decision. The chief points in this connection to which the attention of farmers and other horse-owners ought to be called, are the following. Glanders at the present day is mainly a disease of the large towns, and nearly all the outbreaks which occur in country districts are due to the introduction of some city horse—usually one cast from some large stud. The moral of this is that whoever knowingly buys such an animal and places it with healthy horses runs a more than appreciable risk of having an outbreak of glanders in his stable. If such a recently purchased horse, or any other inmate of a stable into which such a horse has recently been introduced, develops a chronic discharge from the nose, or a firm swelling of the glands under the jaw, or a thick leg, or running sores on any part of the body, it will be prudent to suspect glanders and notify the suspicion to an officer of the local authority.

Prevention.—Although for many years past rigorous measures have been enforced against glanders, the disease is still a very common one in London and a few other large towns. These measures have been successful in holding the disease in check in the large towns, and in preventing its extension among rural horses; but, on the other hand, they have entirely failed in so far as their object was to stamp out glanders The cause of this failure is to be found in facts already stated, the most important of which is that in many cases glanders is for a long period occult in its course. When an outbreak of glanders occurs, it follows that in most cases the stud will include some horses that are already infected, although apparently healthy. Hence, although the law might enforce the slaughter of the visibly glandered animals, it could not be expected to stamp out the outbreak as long as any of the in-contact horses were left alive. The discovery of the valuable diagnostic properties of mallein pointed the way to a more efficient method of dealing with outbreaks. It indicated that the disease might in any given case be stamped out by slaughtering the visibly glandered animals, applying the mallein test to the remainder, and killing or efficiently isolating all of these that react. The Glanders or Farcy Order of 1907, which came into force on the 1st January, 1908, for the first time made it possible for local authorities throughout the entire country to deal with outbreaks under this plan, as a consequence of which a marked decline in the prevalence of the disease may reasonably be expected. [J. M'F.]

Glanders Order. See DISEASES OF ANIMALS ACTS.

Glarner Cheese.—The Glarner (so named from canton Glarus) is one of the recognized cheeses of Switzerland, where it is largely produced for export to adjacent countries, and to some extent for home consumption. It is technically a sour-milk cheese, made generally only from skim milk and buttermilk, for the use of people to whom a low-priced article is a necessity. For all that, however, a sour-milk Glarner cheese of better quality is made for other people by enriching it with one-tenth or so of its weight of cream, and sometimes even of butter, in which cases it is something more than a typical Glarner. It then approximates in quality to full-milk cheese, but the restoration to skim milk of cream or of butter is a process which does not appeal successfully, if at all, to the approval of those who are accustomed to make cheese of milk as it comes from the cow. Such cream restored seems to involve gratuitous and injurious manipulation of milk. A typical Glarner, therefore, is a cheap article made to supply a demand for bulk at the expense of quality, and as such it is merely a skim-milk cheese which is made to utilize a by-product of butter-making, and is only suitable for consumption by men used to constant manual labour. A great variety of sour-milk cheeses is produced in several European Continental countries, where the working classes are content with a decidedly inferior food if only they get enough of it for the money they have to spend. In the making of sour-milk cheese, vessels of copper or brass should not be used, unless they are tinned on the inner side. [J. P. S.]

Glass Eye, blindness in apparently sound eyes, caused by paralysis of the optic nerve. See AMAUROSIS.

Glaucium.—The Horned Poppy, *G. luteum*, is one of the handsomest of our seaside plants, as it forms an erect tuft of glaucous pinnatifid hairy leaves, and bears large orange-yellow poppy-like flowers. The fruit is a long curved pod. Seeds sown in a garden border in May produce plants which flower when about a year old. There are several colour varieties of it, of garden origin, which are grown as hardy annuals, viz. *fulvum*, *tricolor*, and *Fischeri*. The juice of every part of the plant is yellow. [W. W.]

Glauconite, a mineral found in soft greenish grains, mostly small, in sands, clays, or limestones of marine origin. It is a hydrous silicate of iron, potassium, aluminium, magnesium, and calcium, the iron being in the ferric condition. Glauconite often retains the forms of small shells, such as those of foraminifera, within which it has accumulated. Sometimes it appears as casts of the internal tubes of sponge spicules. It is often so abundant as to colour the whole rock mass (see art. GREENSAND). Observations on materials dredged from the sea floor, largely due to the Challenger expedition, show that glauconite forms most favourably at about 100 fathoms from the surface, and is deposited from sea water by an interaction with the decaying animal matter that fills foraminiferal and other minute shells. The grains thus form perfect casts of the interior of these shells, and are preserved when the shells themselves have been dissolved away. In a more rolled and imperfect form they remain in the greensands, although all other traces of minute marine organisms may have disappeared. It has been claimed that the glauconite in a shelly marl in Maryland has a value in supplying potash to the soil (Md. Geol. Survey, Calvert County, 1907, p. 129). [G. A. J. C.]

Glebe, a piece of land assigned to the incumbent of a parochial benefice for his maintenance.

1. ENGLAND.—The incumbent of every parish in England is entitled to a glebe; indeed, so necessary was it considered in earlier times, that without it no church could be lawfully consecrated. Now, however, the possession of a glebe, though usual, is not universal. The extent is nowhere defined, and the size varies greatly, but it is provided by 43 Geo. III, c. 48, that no glebe of upwards of 50 ac. may be augmented by gift by more than 1 ac., while by 55 Geo. III, c. 147, incumbents not possessed of glebe lands exceeding 5 statute ac. are empowered to purchase land not exceeding in the whole 20 ac., to be annexed to the benefice as glebe land. The fee simple of the glebe land is by law held to be in abeyance, but after induction the incumbent practically possesses the rights of a proprietor, qualified, however, by the condition that his personal interest in the estate is practically that of a liferenter, and that beyond this he holds the estate for the benefit of the church and his successor in office. By statutes passed in the reign of Elizabeth it was made illegal for any incumbent to sell, purchase, exchange or take by way of gift any glebe lands; but the hardship involved in modern times by such disabilities has induced the legislature to pass several enactments giving greater freedom of action, and enabling lands suitable for a glebe to be acquired by purchase, exchange, or gift. Facilities for sale were conferred by several Acts, and by the Glebe Lands Act of 1888 the incumbent has power, with the approval of the Ecclesiastical Commissioners, to sell the lands, the price being paid to the Commissioners, who shall either invest the same in the securities specified in the Act, or in redemption of land tax, chief rent, or quit rent charged on the unsold part of the glebe, or in the purchase of other suitable land adjacent to the parsonage. The right to mortgage the glebe is entirely the creature of statute, and is limited to a sum not exceeding three years' net income of the value of the living, the amount borrowed to be repaid in thirty instalments over a period not exceeding twenty-five years. The incumbent has not now at common law the right to open up and work new mines under the glebe lands, but the Ecclesiastical Commissioners may authorize the working of the minerals, the proceeds derived therefrom being paid to the Commissioners and invested by them, the dividends thereof being paid to the incumbent for the time being. The incumbent has the right to fell timber or dig stone on the glebe lands for the necessary repairs of the parsonage, but it is competent, with consent of the patron and bishop of the diocese, to use money got from sale of timber towards the price of lands authorized to be purchased for a glebe. The primary use of the glebe is for cultivation, and the incumbent would, it appears, be bound to cultivate according to the rules of good husbandry. A continued course of miscultivation would probably justify an injunction, but it has been decided that the late incumbent or the executors of a deceased incumbent are not liable to his successor in office for deterioration due to bad husbandry.

2. SCOTLAND.—The incumbent of every proper landward parish or of a burghal-landward parish is entitled to a glebe, but the incumbent of a burghal parish is not. The glebe was primarily to be taken from the church lands, if any, but failing them it is to be taken out of the lands nearest or most commodious to the parish church, but with right to the owner of the lands from which the glebe is taken, of relief against the other heritors in the parish. The glebe is to extend to 4 Scots acres (nearly equivalent to 5 English acres) of arable land; but if there is no arable land, or less than 4 ac., adjacent to the church, the minister is entitled in lieu thereof to 'four sowmes of grass for ilk aiker of the said four aikers of gleib land, extending in the haill to sextene sowmes'. The term 'sowme' or 'soum' denotes the quantity of grass which would pasture, according to some authorities, ten sheep or one cow; according to others, five sheep or one cow; and in one case the Court held it to be equivalent to what would pasture one cow with her calf until a year old. The custom of the district to a large extent regulates the standard, which will vary with the quality of the land in different districts. The right of the incumbent in the glebe is primarily that of a liferenter, he being entitled to the annual proceeds derived therefrom. But his interest is not necessarily

limited to the annual natural fruits, for he is entitled to work the minerals beneath it, at the sight and under the direction of the heritors and presbytery, the proceeds being under their control and management for behoof of the minister and his successors. He has also been found entitled to work marl and to dig peats. Moreover, he has been found entitled to cut down timber on the glebe and appropriate the proceeds to his own use. The incumbent cannot at common law sell, feu, or lease the glebe lands; but by the Glebe Lands (Scotland) Act, 1866, power is conferred on him to grant leases for eleven years, and feus or building leases of the glebe, and to sell servitude rights connected therewith under the conditions stated in the Act. The feu duties and rents derived from the exercise of these powers are payable to the incumbent and his successors in office. The question as to the obligation on the incumbent to cultivate the glebe according to the rules of good husbandry, or the liability he may incur by his neglect to do so, has never arisen in Scotland. According to the maxim that the crop belongs to the sower, an incumbent who has left, or the representatives of a deceased incumbent, are entitled to reap the crop which he has sown and which is unreaped at the termination of his incumbency. See also HERITORS.

[D. B.]

Gleet, Nasal. — A chronic discharge of matter of variable consistence from one or both nostrils is known as gleet; or ozæna where there is a bad odour attaching to it. It may follow upon an ordinary cold or catarrh, or influenza, or the inhalation of impure air, of chemical fumes, or from the presence of pentastomes, or grubs in the case of sheep (*Oestrus ovis*), or from diseased teeth, or necrosis of the turbinated bones or others by which communication can be had with the facial sinuses and nasal passages, which latter act as drainage tubes for the matter formed. The left side is more frequently affected than the right, but no reason for this is known.

Treatment.—A thorough examination of the teeth should be made, as well as of the nasal passages, as it may be that a decayed tooth needs to be extracted, or piece of injured bone removed by trephining the face where a dull area is discovered on careful tapping of the finger over the region. Syringing with dilute carbolic acid, solutions of the sulphates of zinc, copper, iron, and alum, 1 to 3 or 4 per cent, are found beneficial; and the administration internally of iron and copper sulphates, with quinine and gentian, and a liberal diet are advised. Feeding from the ground, and turning out to grass in pure air facilitate recovery.

[H. L.]

Glossitis, Inflammation of the Tongue.—The causes are many, and among them stings of insects, roughened teeth, splinters of wood, nails, and other foreign bodies, and in horses severe or unsuitable bits, and the improper use of the twitch. There is also a form of anthrax specially affecting the tongue and known as gloss-anthrax (see ANTHRAX). The ray fungus causing wooden tongue has been considered under ACTINOMYCOSIS. If the injury to the tongue has not admitted some poisonous material, the inflammation is commonly circumscribed and quickly amenable to treatment, but, as in the famous case of the racehorse Orme, suffocation may threaten by swelling of the organ. Washing out of the mouth and the accompanying foul-smelling saliva with a simple disinfectant is all that is needed as a rule, and ragged ulcers are quickly healed by the application of alum.

[H. L.]

Gloucester Cheese.—There were several types of English cheese—to wit, Cheshire, Cheddar, Leicester, Stilton—which, in the 18th century and before, enjoyed a considerable degree of popularity, and Gloucester cheese, single as well as double, was one of them, though it would suffer in comparison with any of the others in respect to quality and mellowness. The application of the terms 'single' and 'double' signifies size and thickness only, and not quality at all, unless in special cases where the skim milk of an evening is added to the full milk of the next morning and a low-quality cheese is the product. Average chief constituents of both kinds of cheese have been found to be these:—

	Water.	Butter.	Casein.
Double Gloucester ...	36·80	27·30	30·58
Single ,, ...	33·23	28·62	27·85

Generally speaking, a small portion of the evening's cream is skimmed for butter, and the skim milk—still containing a large portion of its cream—is made into cheese along with the fresh morning's milk, which is not skimmed at all. As compared with the cheeses named, Gloucester may be said to have had more fortune than merit in the ancient reputation accorded to it. For all that, however, the Gloucester is a pleasant cheese on the tongue, but it lacks the mellow texture of the Leicester, the high quality of the Cheddar, and the attractive flavour of the Cheshire. In quality these are equal, as a rule, and all of them superior to the Gloucester.

[J. P. S.]

Glowworm (*Lampyris noctiluca*), a luminescent beetle common in some parts of Britain. The female is wingless, the male can fly well. The light is intermittent, and is most marked in the adult female. It probably serves as a signal to the male; but it must be noted that the pupæ, grubs, and eggs are luminous as well as the full-grown insects. There is a concentration of luminosity near the end of the abdomen, where many tracheæ are distributed in two strata of cells like those of the fat-body. The light is probably produced by the oxidation of a substance formed within these cells.

[J. A. T.]

Glucose. See SUGARS.

Glue Refuse. See NITROGENOUS ORGANIC MANURES.

Gluten Meal and Gluten Feed.—Gluten meal, the name given to the nitrogenous or 'glutinous' portion of certain grains, when, as for the purposes of starchmaking, it is desirable to obtain the starch free from the presence of other, and chiefly the nitrogenous, matters. By a process of careful washing out, the starch

is removed and the gluten left, this latter being subsequently utilized as a nitrogenous feeding material. It is also obtained as a by-product in the manufacture of glucose. It is mostly produced in America, and is commonly made from maize, but other grains, such as rice, wheat, &c., may be similarly employed.

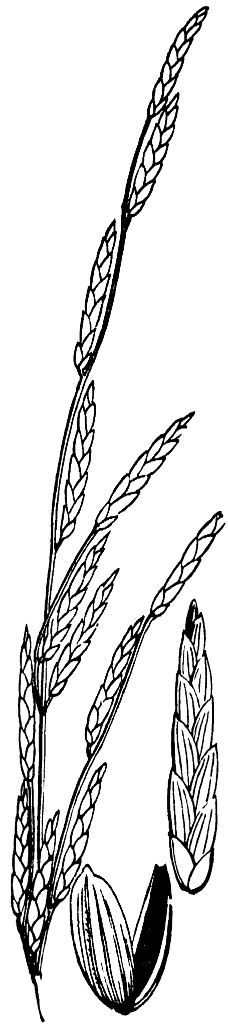
The result is the obtaining of a material which is decidedly rich in nitrogenous matters, and which also has a fair quantity of oil. Its composition will vary according to the grain from which it is made, and according to the amount of bran, or fibre, left in. That with the larger quantity of bran is known generally as 'gluten feed'. The following analyses represent the composition of the two materials:—

	Gluten meal.	Gluten feed.
Moisture	10·39	9·51
Oil	2·79	5·39
[1] Albuminous compounds ...	35·49	24·80
Starch, digestible fibre, &c. ...	48·54	51·97
Woody fibre	1·93	7·26
Mineral matter (ash)	0·86	1·07
	100·00	100·00
[1] Containing nitrogen	5·67	3·97

In the gluten meal it will be noticed that the woody fibre has been removed to a much greater extent than in the gluten feed.

Gluten meal is a highly nitrogenous food, and, as such, is made use of in this country in the manufacture of compound cakes, for the purpose of raising the percentage of nitrogen in them. It is also employed, though not extensively, as a food for dairy cattle. In America, however, it is very largely used both for fattening and for dairy purposes. Being of concentrated nature and rather hard and dry, it is not easy to secure the ready distribution of the nitrogenous matter in a mixed diet of which it forms part. [J. A. V.]

Glyceria.—Glyceria is the name applied to a genus of aquatic or sub-aquatic grasses readily eaten by stock, and closely allied to the Poa or Meadow-grass genus, from which it is distinguished by the long linear spikelets, which are cylindrical and not flat. The only species interesting to agriculturists is *Glyceria fluitans* (*Poa fluitans*, Scop.), commonly called Floating Sweet Grass, Floating Meadow-grass, or Manna Grass. This species is very common on most watery ground in Britain, either on mud or peat. Along with it, especially on peat bogs, grows the Fiorin (*Agrostis alba*), but the Sweet Grass is readily distinguished by the much broader leaves, and by the long spikelets of the ear. Sweet Grass is a perennial which begins its growth very early in the year, producing long creeping stems, from which erect stems rise through the water and extend for a foot or two beyond the water surface. The broad leaf-blades float, and conceal the water beneath. The ear is produced about the beginning of July, and is a panicle of long cylindrical spikelets. In four or five weeks the ear ripens and produces seeds (grain fruits), which, like those of wheat, lie free within the husk (pales), and are readily picked or threshed out. In parts of Germany these seeds are collected and used for brothmaking, sometimes as food for goldfish. The grass is important, at times, for water meadows and marshy fenland, where it may be cultivated by propagation from cuttings, or grown from seeds planted in the mud.



Glyceria fluitans

The shoot of Floating Sweet Grass is distinguished from that of every other water grass by the following points:—

1. The shoot, as a whole, is flat (not cylindrical), and when chewed has a sweet taste.
2. The sheath is entire and ribbed, with a well-marked projecting keel along one edge. When held up to the light it appears divided into rectangular areas owing to the presence of large air cavities within.
3. On each side at the base of the leaf-blade there is a well-marked triangular area, coloured yellow, not brown.
4. The leaf-blade has *acute ribs*, both on the *upper* and on the *lower surface*. [A. N. M'A.]

Glyciphagus domesticus (the Household and Meal Feathered Mite).- This small mite is frequently very annoying in houses, outbuildings, and in stores. It feeds on hay, flour, meal, straw, bran, cork, tobacco, dried fruits, and unclean horse hair. With the latter it is often taken into houses in upholstered goods. Eight other species of Glyciphagus occur in Britain, three are common in stable fodder, &c., the others live in squirrels' nests and in company with moles.

These minute acari deposit their eggs amongst the substances upon which they live. The ova are comparatively large, oval, smooth-shelled, dull-grey bodies. The young or larvæ have six legs, then they moult and become eight-legged nymphs, and later become sexually mature after moulting twice. An additional stage occurs in these acari, a so-called *hypopial* stage, the mites assuming a different appearance. In this condition they are more readily attached to insects, and thus get distributed as well as by the wind.

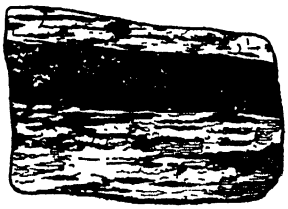
Treatment in stores, &c., is best carried out by fumigation, either with bisulphide of carbon, or

hydrocyanic acid gas. The rooms and bins must be well cleaned out, and washed down with some strong disinfectant. Upholstery invaded by them can only be cleaned by being unpacked, and the horse hair or flock stuffing baked.

[F. V. T.]

Gnats, a popular name for small insects of the nat. ord. Diptera, which are specially abundant in marshy places, and which live mostly on the blood of animals. See CULEX.

Gneiss.—A rock of crystalline structure in which the minerals or groups of minerals are arranged in fairly parallel layers is said to be *foliated*, and gneiss may be broadly defined as a foliated granite. Some gneisses are of more basic character, and we thus have dioritic types; but the majority consist mainly of quartz, orthoclase and other felspars, and light and dark mica. These minerals are so grouped as to give



Gneiss—showing Foliated Structure

a streaky character to the rock when it is broken across the foliation. In many cases this structure is due to the flowing of the rock in a plastic state after the crystals had begun to develop in it. In other cases, pressures within the earth have deformed the constituent crystals, and have made them flow in a solid state over one another, many of them becoming ground to powder in the process. In other cases, the gneiss is strikingly banded, layers of different rock types alternating with one another; such are the *composite gneisses*, which result from the intrusion of sheets of granite in a molten state along the bedding planes of a sediment, or along the foliation planes of a schist or of some foliated basic igneous rock.

In the British Isles, the most extensive area of gneiss occurs in the Outer Hebrides, where the nature of the rock and the exposed geographical position combine to provide difficulties for the crofters. Oat crops, however, are raised around the scattered one-storied farms; but peat and lakelets occupy much of the interior. Many areas of gneiss occur in the Grampian region (see art. DALRADIAN). A large part of Canada east of the Rocky Mountains is formed of gneiss, its surface being fortunately ameliorated by glacial drift. While most gneisses are pre-Cambrian, this is mainly due to the fact that those of more modern origin have not yet been exposed by denudation; and there is a growing tendency to regard many gneisses in central Europe as of post-Carboniferous age.

Gneiss soils are usually poor, and naturally resemble those derived from granitic rocks. Even low-lying gneissic areas are likely to be abandoned to peat and heather. The resistance of the rock to denudation, moreover, often leads to the formation of highland areas, with barren mountain ridges and very little level land.

[G. A. J. C.]

Goat.—Notwithstanding obvious external differences, goats (genus Capra) stand zoologically so close to sheep that 'there is every reason to believe that both have arisen in geologically modern times from a common group which is probably to be looked for among the antelopes'. The horns of the goat rise upwards and curve backwards, diverging much less than those of the sheep. They are laterally compressed, or keeled. There are certain differences in dentition; the goats have the incisors more deeply rooted, and the molars thinner and bent slightly forwards. The coat of the goat is of thick, coarse, bristle-like hair, springing from among softer short hair, and forming a beard at the chin. Goats are exceedingly active and sure-footed, very intelligent, and playful almost to roguishness.

The geographical range of the goat extends throughout all the mountainous regions of Europe, Asia, and northern Africa, each region possessing characteristic forms. The best known and most widely distributed of the goats in the strict sense is the Bezoar (*Capra* or *Hircus ægagrus*), which occurs in Crete and eastern Europe, and in Asia as far east as to Afghanistan. It is reddish-brown in colour, with a well-developed beard; the horns have large tubercles in the male, increasing in number with each year of age. The once precious bezoar stone, used as an antidote to poison and otherwise, seems to be a secretion in the stomach. Farther east and in Afghanistan the bezoar is replaced by the Markhor (*C. falconeri*), a larger species with spirally twisted horns, and a rough mane on head and breast. The horns of the male Markhor may attain a length of 5 ft. or more, and are a trophy much prized by huntsmen, since the animal's haunt is on rough, rocky ground between the forest and the snowline.

The ibexes, sometimes referred to a separate genus, are not usually regarded as having a place in the pedigree of the domestic goat, although goats can be crossed with ibexes, and the hybrids are said to be fertile. The Alpine Steinbock (*Capra ibex*) is now reduced to a few herds living in the Piedmontese Alps; happily, it is strictly protected by the King of Italy. The Spanish Ibex (*C. pyrenaica*) is at home on the Pyrenees. (See art. IBEX.)

Keller regards most of the races of domestic goat—the common (*Capra hircus* of Linnæus), the black-necked, the hornless, the Mamberg, the African dwarf goat, &c.—as derived from the Bezoar. The Cashmere goat is undoubtedly a descendant of the Markhor, and the Angora probably owes its origin to a blending of the two forms, the Bezoar element predominating. It is said that *Capra jemlaica* of the Himalayas has also yielded a domestic race in India.

The Cashmere goat (see art. CASHMERE GOAT) is reared in great numbers in Tibet, and its long hair also forms a valuable article of commerce among the wandering Kirghiz of the Steppes. Kashmir is the centre of the manufacture of the well-known shawls and cloth, into which the

finest qualities of hair are woven. The Cashmere goat has been successfully introduced into France.

The Angora was bred originally at Angora, in Asia Minor, for the sake of its fine long silky hair, known as 'mohair'. It has been acclimatized in New Zealand and also in Cape Colony, where it has proved particularly profitable, the hair, it is said, having improved so much in quality that it is now better than that of the goats in their original home. More recently it has been introduced with apparent success into Australia and California. (See ANGORA GOAT.)

The numbers of domestic goats kept in Europe are, it is said, decreasing rapidly; but, in Switzerland and Austria in particular, large flocks are still to be seen, and over 60,000 goats are driven to pasture in the Alps during the summer months. In France large flocks are no longer very common, but in many districts a single goat tethered by the wayside may be seen beside almost every cottage. In Ireland goats are still fairly numerous, but in England and Scotland they are seldom kept, and almost no attention is paid to breeding them. Yet goats have very modest wants, and many uses. The milk is at once richer and easier of digestion than that of the cow; the flesh, especially of the kid, is savoury; the skin makes a fine soft leather; the hair can be used for ropemaking, and the horns for knife handles. Against these advantages we have to place the goat's extreme destructiveness to young trees. See articles below. [J. A. T.]

Goat-farming.—When the novice finds a few goats profitable, it is natural that he should think of the possibilities of goat-farming. But so far as we know, no goat farm has as yet been established in this country as the sole means of its owner's livelihood and proved profitable. This is not to say that a profitable goat farm may not be established some day. It is necessary, however, to take note of the difficulties which stand in the way of success. We sincerely trust that they may be overcome, as the increased provision of the rich, non-tuberculous milk—which is so excellent for children and for the ailing—is greatly to be desired. Some of the leading goat-keepers are content to keep their animals mainly as a hobby, so that their herds of two or three dozen do not pay. The great drawback to goat-farming is the labour involved. As goats yield less per animal than cows, it would obviously need a large herd to provide a substantial quantity of milk. This means a great deal of milking. And unless goats are milked clean the amount of their yield diminishes rapidly. In the second place, it would be imperative that everything should be done to ensure the health of the herd. If the stamina of the herd were weakened, there would be a chance of disease making its appearance, with disastrous results. To ensure hygienic conditions it would be necessary above all things that the goats should have a wide range. The range should be dry, cheap land, and it is by no means easy to get such land near large centres of population, which would naturally furnish the best market for the milk. The land would also have to be effectively enclosed in some way, or wages would have to be paid for herding. Further, the land should not be too poor, for it would be well that it should furnish a certain proportion of the goats' food. On inexpensive feeding a great deal of the success of the goat farm would depend. The land must also possess, or be provided with, shelter of some sort. In order to keep up the supply of milk in cold weather, it would be necessary to feed highly nitrogenous hay, which would seem to involve the growing of lucerne, clover, or similar crops. It is not easy to imagine all these conditions complied with. Every one of them is requisite, however, and if any one is absent it must be compensated for in some way. Need it be added that strains of goats should be kept that yield a satisfactory amount of milk? Unless the capitalization of the farm were going to be heavy, this would seem to involve the herd being gradually worked up in point of numbers, for the good milkers which are not past their first youth cannot be got for nothing. Some plans of goat-farming have no doubt been put an end to by the refusal of the Board of Agriculture to permit the importation of foreign goats. If the experiment in importation, which is promised by the Board, should have no untoward results, and importation of goats from the Continent should be permitted under conditions which do not make the animals unduly expensive, there might be an incentive to goat-farming which has not existed in the past. The thing which would help most to make goat-farming profitable would be an increased demand for goats' milk. At present, in spite of all the propagandist work of the Goat Society, and the influence of books on goat-keeping, the demand for goats' milk is still inconsiderable. The medical profession is by no means as well acquainted with its merits as might be expected. As to the general public, in answer to enquiries made by the present writer of three of the leading London dairy companies, one replied that 'we gave up keeping goats some years ago'; the second, that 'we have no demand for goats' milk, or at all events on very rare occasions indeed'; and the third, that 'the demand is so small that it would not pay us to purchase a regular supply even in the smallest quantities. We received only one enquiry between April 1904 and August 1905.' To our knowledge, one of the largest goat-keepers in the country cannot find any market for his milk, and gives it away to the children of his hamlet. A number of experienced goat-keepers, consulted by the present writer on the commercial possibilities of goat-farming, sent the following replies: 'People will not pay the price necessary to make it a commercial success.' 'No; a certain profit may, of course, be made under exceptional circumstances, but to all intents and purposes the answer is "No."' 'Certainly, if a market could be found for the milk. At present the prejudice is too strong. The stock would be also very difficult to obtain, as importation is forbidden.' 'The commercial possibilities are no doubt many by selling milk and selling goats in milk to meet the demand.' 'No, the public do not appreciate goats' milk or meat. If they did, goats might be kept on land

too poor for other stock, only one would want them tethered, or, if kept loose, strong fences would be required—an expense too great to contemplate.' 'One proprietor only. Live amongst them, milk and feed them oneself, and, if necessary, with the help of one's own family. . . . One would have to start in a small way. Breed good ones and sell at good prices. Most of the milk would have to be sent away by rail, no one district would provide a large enough market. One would have to have some other source of income for the first few years. Only one in a hundred, I am afraid, could make a living.' 'I think a goat farm would rarely succeed. There are places where a considerable number of persons may be found who will pay a good price for goats' milk for invalids and children, and there a small goat farm might succeed.' 'Goat-farming is a possibility, I think.' It will probably be found that poultry keeping, market gardening, beekeeping, or some analogous pursuit may be advantageously combined with goat-farming. The best chance for a goat farm, we think, would be in connection with a sanatorium for consumptives. The land which suits consumptives would suit goats; there would be cheap labour, and the milk for sale would be well recommended. See the art. GOATS, BREEDING AND MANAGEMENT. ['H. C.']

Goatling, a term given by the British Goat Society to a she goat over twelve months of age and not exceeding two years, corresponding to heifer in the bovine species.

Goat Moth, a large British moth whose larvæ are destructive to the heartwood of timber trees. See COSSUS LIGNIPERDA.

Goats, Breeding and Management.—The breeding of goats in England was for many years confined chiefly to cottagers; but with the advent of goat shows, and the formation of the British Goat Society (see that article), people of means and influence began to turn their attention to improving the goat as a milk supply, with the result that some of these animals are now met with yielding a gallon of milk a day. Goats are very profitable stock when kept privately for the supply of milk in the household, as they consume all the waste produce of a garden, and even scraps of bread and vegetables from the kitchen; but goat-farming on a business footing, as advocated now and again by people who have had no experience of the subject, can never become a thriving industry so long as there exists no market for goats' milk on a commercial scale, as is the case at the present time. See GOAT-FARMING.

The chief drawback to goat-keeping both as a business undertaking and for a domestic milk supply consists in the fact that it is difficult to get these animals to give milk in sufficient quantity during winter. The goat drops her kids generally from February to July, occasionally in August, but rarely after that month, so that the goat-keeper has usually to fall back on the ordinary milkman during November, December, and January. Intercourse between the sexes generally takes place from September to February, and occasionally in March and April, but fertility becomes very uncertain during the two latter months. Goats are extremely precocious animals; the male is capable of engendering at as early an age as three months, whilst the female will often produce kids before she is a year old. This early breeding, however, should not be permitted if size and constitution are desired. To obtain good stock, and to allow the goat herself to acquire a proper development, she should not be mated before attaining the age of fifteen, or preferably eighteen months, whilst the male should be at least twelve months old. A goat may produce from one to four kids at a birth, but two give the best results, as when there is a larger number they are generally small, and it takes an exceptional milker to rear properly four or even three kids. When males are born it is best to destroy them at once, as they do not pay to rear, and become a nuisance as they grow up. Their objectionable odour and disgusting habits render them unsuitable as pets, unless they have undergone emasculation; and though if killed and eaten when they are a month old the flesh is tender and juicy (provided the animal has had plenty of milk), the value of the milk consumed places the price of the meat at a very unprofitable figure.

Kids that are intended to be reared require to be suckled until they are eight weeks old, at which age they can make up with grass and hay for the loss of milk. If exceptionally fine stock are required, however, the weaning period should be deferred for at least another month, for the longer the milk supply continues the better grown will be the kid. When a goat has more kids than it can rear properly, and the stock is valuable, one or two can be brought up by hand with an ordinary infant's feeding-bottle; but this method should be adopted preferably before the offspring are a week old, as the longer they have been kept on the dam the more trouble will it be to get them to take to artificial feeding. Goats' milk should be supplied at the earlier stage, but when a month old, or before if absolutely necessary, cows' milk may be substituted.

Goats vary greatly in their yield. A goat is not worth keeping that gives less than a quart a day with its first kids, but many give double this quantity, and at the next kidding from 3 to 6 or even 8 pt. may be obtained. A really good milker should supply 2 qt. a day in its full flush with its second lot of kids. The period of lactation in a common specimen varies from six to nine months, but in superior stock, and especially in certain breeds like the Toggenburg, lactation may last a whole year, and indeed it is difficult in some animals to dry them off before parturition recurs. If a goat of this kind is not mated again, it may continue in milk for two or three years, and though the yield may greatly diminish at the approach of winter, it will generally be resumed to a more or less degree with the fresh grass the following spring. A goat not infrequently will supply a certain and appreciable quantity of milk without ever having been mated, and this is usually a sign of an abundant milker. The milking of a goat should be performed in the same way as with a cow, but if the teats are very small—

which is regarded by judges as a bad feature—the milk has to be drawn by a stripping process, *i.e.* repeatedly pulling down the teat between the forefinger and thumb. A goat should be milked morning and evening if it yields 2 qt. a day or less, but three times is better if more than that quantity be supplied. Goats are fed in very much the same way as cows or sheep, but the variety of food they consume is considerably greater. Pasturage is not necessary, and when given should be changed after a time, as these animals contract a peculiar wasting disease if pastured for two or three years in succession on the same ground. Tethering has usually to be resorted to in cultivated districts, as the destructive capabilities of one of these animals when loose in a garden or orchard are well known. A tether should consist of a chain 12 or 14 ft. in length, fitted by a springless hook and a swivel to a tethering-pin about the same number of inches long. The other end of the chain should have a spring hook to fasten on to the goat's collar, or preferably headstall.

A goat may be kept almost entirely stall-fed in a stable or goathouse all the year round. Under this system the food consists, in the way of provender, of hay, oats, and bran, with an occasional change to crushed maize, and now and then a little linseed cake. This should be supplied night and morning. During the day it may have the washed peelings and surplus leaves of all vegetables, or swedes and mangolds, given whole rather than cut up. The leaves and bark of trees of nearly every kind, acorns, weeds, such as thistles, dandelions, plantain, &c., ivy cuttings, fruit-tree prunings, and hedge clippings—all provide useful food for these animals. The chief points to remember in feeding a goat are to give as great a variety as possible but not too much at a time, and to give it always fresh and absolutely clean, as anything the least soiled or that has been trampled upon, whether grass, hay, or vegetables, will invariably be refused. A goat that is milking and one that is stall-fed requires water twice daily, but dry goats and those at pasture, except in hot weather, drink but little. Rock salt should be kept where a goat can have access to it to lick.

All goats require to be housed more or less in winter, and even in summer they should be taken in during the night, unless they are free and have a shed in which to take shelter from great heat or rain as they may desire. The average age of a goat is from eight to ten years, and it is capable of breeding during the whole of that period, but except in special cases it is not desirable to breed from a she goat after seven or eight years. [H. S. H. P.]

Goats, Breeds and Varieties.—The goat is met with in nearly every part of the world, and different countries claim to possess their own breeds and varieties. The distinct breeds, however, are very few, and although the varieties may be numerous, any distinguishing features they may possess are often so slight, that in many cases it would be difficult even for an expert to select the particular kinds named after their respective localities. Amongst these may be cited the Gruyère, the Couclair, the Westphalian, the Hinterwalder, the Tarentaise, the Schwartzenberger, the Langensalzaer, and many others whose names are given by French and German writers, but which are simply local names applied to a general type of goat common to certain mountains or districts. Goats possessing sufficiently distinctive characteristics to warrant their being described as breeds are chiefly the following: In the East: the Angora, the Cashmere or Tibet goat, the Nubian, and the Syrian. In Europe there are the Alpine, Saanen, Toggenburg, and Schwartzhals, met with in Switzerland; the Alpine and Pyrenean in France; the Murcian and La Mancha goat in Spain; and the Maltese in Malta, parts of Italy, and in Algeria. The Angora and Cashmere, the only breeds that are kept in large herds as a commercial industry, have special articles devoted to them (see ANGORA and CASHMERE). Similarly the Nubian, Syrian, Saanen, Schwartzhals, Toggenburg, Maltese, and Pyrenean will also be found dealt with under their several headings.

The Alpine goat is included in the above list, although it can hardly rank as a distinct breed. The name represents a type of goat common to the French and Swiss Alps which is met with in every variety of colour and markings. In certain districts, however, this goat has been bred with some uniformity in these respects, and we get such varieties as the Saanen or Gessenay, and the Appenzell, all white; the Sundgau, chiefly black, with white markings; the Coublanc or Couclair, black, with white necks, and the Tarentaise. The Toggenburg should strictly be classed in this category, being also an Alpine variety, but the colour and markings are so peculiarly its own, and it has been bred true to type for so many generations, that it deserves to rank as a separate breed.

The Murcian and La Mancha goats of Spain are short-haired kinds but little removed from the common goat, except in the case of the latter, which is remarkable for its very small upright ears.

In the British Isles two varieties of the common goat are met with which are probably indigenous, the one being short-haired and the other long-haired. The former is generally regarded as the English goat, and the latter the goat of Wales and Ireland. They differ also in some other respects. The English goat has horns which are set rather far apart, rising slightly at first, with an inclination to branch outwards with a gentle curve, the head is short and tapering, and the body long and deep. The Irish goat is a gaunt, shaggy animal with a long head and coarse muzzle and a considerable amount of beard. The horns are long and pointed, and rise almost perpendicularly, whilst inclining to the rear. The colour is generally grey, brown, or black, more or less mixed with white. The Welsh goat resembles the Irish, but is smaller and more gracefully built.

Of recent years, that is since 1875, the date of the first goat show, a made-up breed has sprung up, produced originally from a careful selection of the best English milking goats crossed with imported Nubian or Indian males, and known

as 'Anglo-Nubians'. This breed has the advantage of a close, shiny coat, which is more easily kept clean, whilst the lop or semi-lop ears and peculiar conformation of head, derived from the Eastern blood, gives a breedy aristocratic appearance to the animal that has rendered it extremely popular, so much so that the best strains and the principal prizewinners have been of this cross. [H. S. H. P.]

Goat's-beard.—There are two species of composite weeds included under this designation, the Yellow Goat's-beard (*Tragopogon pratensis*) and the Purple Goat's-beard or Salsify (*Tragopogon porrifolius*). See TRAGOPOGON and SALSIFY.

Goats' Milk. — The superiority of goats' milk to cows' milk as a food for infants and for persons suffering from wasting diseases has been attested by the medical profession and writers on the goat not only in England, but to a still greater extent in Germany and France. The late Dr. Augustus Voelcker, who analysed and examined numerous samples of this milk, attributed its digestibility to the small size of the cream globules, these being contained in a more perfect state of emulsion than in cows' milk. Certain it is, as proved to the writer's own knowledge in hundreds of cases, that infants deprived of their natural sustenance, which were losing flesh and were practically doomed to an early death whilst being fed on cows' milk, were restored and grew up strong and healthy by the use of goats' milk. The researches of Dr. Barbillion of Paris, as reported at the International Congress of Medicine, further showed that whilst the curd of cows' milk forms a dense adhering mass, which by agitation separates into clots that are but slightly soluble, the curd of goats' milk forms into very small light flakes, which are soft, very friable, and very soluble, like those in the milk of the ass and in human milk. Submitted, moreover, to the action of digestive ferments, these milks were digested completely in twenty hours, whilst the same process applied to cows' milk showed only a very slight advance after sixty hours.

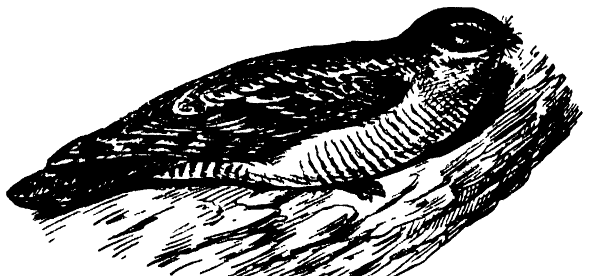
Another and still greater feature of goats' milk is its almost complete freedom from tuberculous germs, owing to the fact that the goat is nearly immune from tuberculosis. Professor Nocard, an eminent authority in France, is stated to have reported, according to an article on the utility of the goat in the Revue des Sciences appliquées, that 'out of over 130,000 goats that were brought to Paris for slaughter, the meat inspectors of that city had failed to discover a single case of tuberculosis'.

Apart from its medicinal and sanitary qualities, goats' milk for domestic use alone is far superior to cows' milk; when taken in tea or coffee, or used for culinary purposes, it imparts a creamlike effect on the palate, so that people who have once used it are very loath afterwards to revert to cows' milk. Objections are now and again heard against goats' milk, on the ground of it possessing a peculiar goaty flavour. This, however, is rarely or never the case when the vessels into which the milk is drawn or subsequently placed are absolutely clean, and when the milk has been properly cooled, as it should be after coming from the animal. Another source to which may often be attributed a certain taint in this milk is the dirt falling from the body of the goat at milking time. This is still more pronounced when the animal has been in contact with the male, whose powerful and unpleasant odour is communicated to everything it touches. It follows from this that the udder of the goat should be washed previous to milking, and that the milk should be carefully strained through a fine cloth before being put away for use.

Goats' milk is whiter than cows' milk, and contains generally more butter fat and more casein than the latter. It varies considerably, however, in these constituents according to breed. Thus in the Swiss and Alpine varieties, which are heavy milkers, the milk is relatively poor. In the Eastern varieties, on the contrary, such as the Mamber goat of Syria, the Nubian, and the Angora, the proportion of butter fat is very considerable. At the Dairy Show of 1904 the first prize winner in the milking competition for goats gave 7·52 per cent of butter fat, and 9·54 of other solids, whilst on another occasion an Angora goat, the property of the writer, gave milk with over 9 per cent of fat.

Goats' milk can be made into butter in the same manner as cows' milk, but owing to its entire absence of colour it has the appearance of lard, and requires therefore to be artificially coloured. This milk is more suitable for the manufacture of cheese, several varieties of which are made in France. The most famous goat cheeses are Mont d'Or, Levroux, Sassenage, and St. Marcelin. [H. S. H. P.]

Goatsucker, or **Nightjar** (*Caprimulgus europæus*). — This bird, also locally known as 'Fern Owl', 'Churn Owl' (in reference to its remarkable note), and 'Night Hawk', belongs to



Goatsucker (*Caprimulgus europæus*)

a special family related to the swifts and woodpeckers, and is not a bird of prey as often supposed. It is about 10 in. long, and dull-grey in colour, marked with darker streaks and dots. The wings and tail are reddish and flecked with white. The large eyes are in accordance with its nocturnal life. The bird has a curious habit of crouching on branches in the direction of their length, in which situation the colours and markings of its plumage render it very inconspicuous.

The short broad bill and wide gape fringed with bristles attest an insectivorous habit. The Goatsucker is a summer visitor, arriving about the middle of May, and leaving again in September. Its two eggs are laid on the bare ground, which they resemble in colour, being marked with brown spots on a yellowish-white ground. The bird is entirely beneficial to agriculture, and purely insectivorous. When night falls it catches insects on the wing, and destroys large numbers of injurious moths, as well as flies, midges, and beetles. Heaths and commons are especially favoured by it, and the fact that it is often found near cows, sheep, and goats has given rise to the old but baseless notion embodied in the name 'Goatsucker'. The real attraction is furnished by the numerous insects that abound in the neighbourhood of domesticated animals. [J. R. A. D.]

Godetia, a genus of ornamental annuals belonging to the ord. Onagraceæ, and allied to evening primroses (Œnothera). They thrive in ordinary garden soil, provided they get plenty of sunshine. The seeds should be sown in April, preferably in large patches, the plants being most effective when grown in that way. When the seedlings are strong enough, they should be thinned to about 8 in. apart. Better results are thus obtained than by raising plants in boxes and transplanting them. The best varieties are of garden origin, viz. Duchess of Albany, Lady Albemarle, Princess of Wales, The Bride, &c. These are all the progeny of *G. rubicunda*, a Californian weed. [W. W.]

Godwit.—Under this name are included two species, related to the snipes and sandpipers, which visit this country in spring and autumn, on their way to and from their breeding grounds in the Arctic regions. They are coast-haunting birds, with slender legs, and long, narrow, slightly upturned beaks. (1) The Bar-tailed Godwit (*Limosa lapponica*) is about 15 in. long, spotted with brown on its upper side, and distinguished by white bars on the tail when in summer plumage. It is found on all our coasts. (2) The Black-tailed Godwit (*L. belgica*) is somewhat larger, spotted with chestnut, and possessing a black tail. It is to be found on the east coast, and more rarely in Ireland and Scotland. Godwits feed on insects, worms, and snails, being in the main beneficial to agriculture. [J. R. A. D.]

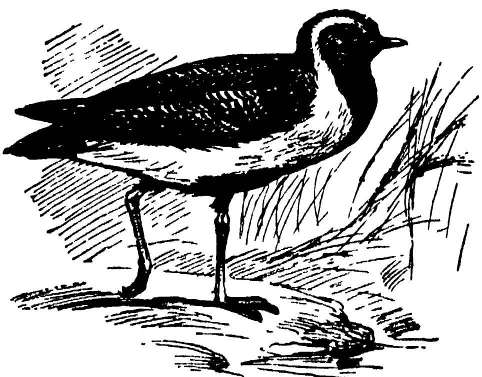
Goitre.—Enlargement of the thyroid glands may occur in animals, but is not common, and still more rarely of consequence, or permanent in its ill effects. Some tenderness and swelling is observed on one or both sides of the throat quite close to the larynx, and should be treated by applications of iodine ointment twice or three times a week, and internal administration of iodide of potassium. See MEDICINES, DOSES OF. [H. L.]

Golden Chafer, a beetle of a beautiful metallic gold and green colour, a pest in the flower garden. See CETONIA.

Golden-eye Fly, a dipterous insect with bright golden-green eyes. See CHRYSOPA.

Golden Oat Grass, a tall perennial grass resembling the oat in its appearance. See AVENA.

Golden Plover.—The Golden Plover (*Charadrius pluvialis*) is most plentifully distributed in England during the colder months of the year. In September, October, and November large flocks come from the North, the young birds arriving first, and the adults later. A general movement northwards takes place again in March. In spite of this migratory habit, large numbers remain to breed with us. On the hilly parts of the west of England they nest regularly, and in the North of England and Scotland they become more abundant as we go farther north. The birds, which breed on the moorlands in this country, mostly go down to the coasts for the cold weather. The Golden Plover is found all over the north of Euroqe and a great part of northern Asia. On



Golden Plover (*Charadrius pluvialis*)

migration it sometimes goes as far south as the south of Africa. The food of the Golden Plover consists chiefly of insects, slugs, worms, &c. The nest is little more than a slight depression in the ground, frequently without any cover at all. Four eggs are laid, of considerable size. The bird's well-known whistling note needs no description. There is a great difference in the plumage of the Golden Plover in the summer and winter. In the summer the male has the crown and mantle blackish, and the whole of the under parts are black. At the autumn moult the black colour is lost; the under parts become white, and the upper parts brown thickly spotted with yellow, whence the bird derives its name. The winter plumage is retained till February or March. [H. S. R. E.]

Golden Rod, a small composite plant with flowers of a bright golden colour common on chalky soils. See SOLIDAGO.

Goldfinch (*Carduelis elegans*).—This beautiful little resident is easily recognized by its scarlet face and throat, black crown, and black wings barred with yellow and tipped with white. The male also has some yellow on the breast, and his colours are brighter than those of his mate. Breeding begins in May. The pretty cup-shaped nest is commonly built in gardens or orchards, sometimes among evergreens, and consists of moss, wool, and vegetable fibre, lined with various soft materials. The four or five

eggs are spotted with red on a bluish-white ground. There may be a second brood in the season. The adults are seed-eaters, being particularly fond of thistles and stinging nettles, but the young are reared on insects. During winter the bird is a gipsy migrant, small flocks roaming about waste land feeding on seeds and berries, and destroying weeds. Although a small amount of damage may be done to the seeds and buds of trees, the species is almost entirely beneficial to agriculture and deserves the most rigid protection, especially as its numbers are being rapidly depleted by the professional bird-catcher. The arrival from time to time of migrants from the Continent does not compensate for the wholesale and mischievous destruction that is constantly taking place. [J. R. A. D.]

Gold of Pleasure, an annual weed belonging to the nat. ord. Cruciferæ, frequently found in corn and flax fields. See CAMELINA.

Gold-tail Moth. See PARTHESIA.

Goniocotes eynsfordii (the Tick-like Fowl Louse), a fowl louse which is particularly partial to chicks, seldom leaving the head and neck. They are most prejudicial to the health of the birds. They are found with their heads buried in amongst the feathers and their bodies in the air, just like a tick (Ixodes). The female is 2·7 mm. long; ground colour pale-grey, the lateral bands dark shining chestnut-brown; a double pair of horizontal lateral stripes on each segment, chestnut-brown in colour, much darkened towards their outer edges, and thus forming a ready feature of distinction. Male narrower than the female, bright yellowish-brown, borders of the segments very dark brown.

The louse lays its eggs on the feathers as whitish 'nits', with distinct hexagonal sculpturing, and attached at one end by means of delicate threads. The young lice are like the adults, only pale in colour, as they are also after each moult.

Treatment consists of dressing the neck and heads of the chicks with mercurial ointment, which may be applied by pulling the neck against the fingers covered with the ointment, or, better still, with plain salad oil, as there is some risk in using the former. [F. V. T.]

Goniocotes hologaster (the Sedentary Fowl Louse).—This is a fowl louse which is very partial to the rump and back of the birds. The female is only 1·3 mm. and the male ·8 mm. in length; in colour it is dirty-yellow, chestnut-brown on the thorax; the head is large, with two long bristles on each side of the lower angles and some short ones in front. The abdomen is swollen, and has dark-brown quadrangular lateral bands to the segments.

A much larger species, *G. gigas*, which reaches 4 mm. in the female, 3 mm. in the male, is also found on poultry. It is yellow in colour, and can be told by the large round abdomen, which has pale-brown patches, coloured with dark-brown at the border. For treatment of lice see MALLOPHAGA. [F. V. T.]

Good King Henry (*Chenopodium Bonus Henricus*), a common perennial weed belonging to the nat. ord. Chenopodiaceæ (or Goosefoots), found in waste places, by roadsides, and by farmyards. The plant is deep-green in colour, has a short stout stem, and grows from 1 to 2 ft. high. The leaves are triangular, and the flowers are borne in compound lateral or terminal leafless spikes. This plant was formerly largely cultivated in gardens as a potherb. It is very palatable when boiled, and resembles spinach in flavour.

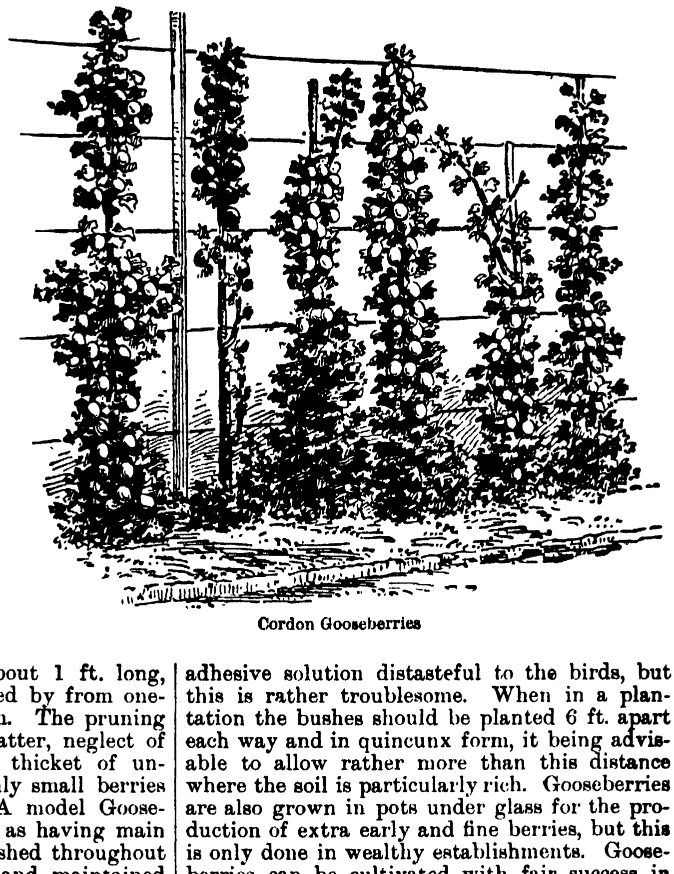
Goose. — The European domestic race is derived from the Grey or Grey-lag Goose (*Anser ferus* or *cinereus*), which is widely distributed in the Old World. This Grey Goose used to breed abundantly in the English Fen country, and the young were often kept along with the flocks of tame birds. A few still nest in remote parts of the Highlands and in the Hebrides, but the bird is no longer common in Britain. The geese that are oftener seen—especially in winter—are the Pink-footed (*Anser brachyrhynchus*), the White-fronted (*A. albifrons*), the Bean (*A. segetum*), the Bernacle (*Bernicla leucopsis*), and the Brent (*B. brenta*). Of these the last is most abundant, and widely distributed in Britain. When these wild geese are abundant, and they have their favourite haunts, they sometimes do considerable damage in the fields. Geese were domesticated in ancient times, as we know from Homer and from the story of Juno's geese in the Capitol at Rome, but it is noteworthy that the domesticated race has departed but little from the characters of the wild species. It is bigger, whiter, more palatable, and more fertile, but, as Darwin pointed out, 'the amount of variation which it has undergone, as compared with most domesticated animals, is singularly small'. This is partly due, no doubt, to the fact that selective breeding of geese has not been practised to any great extent, though some preference has always been given to white stock. The common wild goose of America (*Branta canadensis*) has been domesticated in Britain for more than two centuries. For the goose in its connection with agriculture, see art. GEESE. [J. A. T.]

Brent geese are much sought after by punt-gunners at the mudbanks in estuaries, where they come to feed. The shoulder-gunner may come within range of them, by the plan of concealing himself in a cask sunk out on the mud flats. For a punt-gunner to attempt to approach grey geese on the water in the daytime is a veritable 'wild goose chase'. Professional gunners only attempt to approach them at night, when a single shot in their midst, as they rise from the water, will often bring down large numbers. With a shoulder-gun, the best chance is to waylay the birds on their morning or evening flights to and from the feeding grounds, or to have them driven, bearing in mind that they always fly up wind on rising. [H. R. S. E.]

Gooseberry.—The Gooseberry (*Ribes Grossularia*—nat. ord. Saxifragaceæ) is widely distributed in a wild state over the Northern Hemisphere, including Britain. It is not, however, so extensively cultivated in all the countries favourable to its growth as is the case here; indeed, it may be said that it is in England, especially in the northern counties, that

the finest Gooseberries are produced. Notably inferior varieties are commonly met with on the Continent, and the climatic conditions of North America not suiting it so well, it is not nearly so much in evidence there. It has been cultivated in England since the reign of Henry VIII, if not before, and in this period the size of the berries has been most notably increased. The Gooseberry is perhaps the most valuable of the bush fruits; it can be relied on to bear a fair crop of fruit, indeed in most seasons it yields abundantly; its season extends over many weeks, and Gooseberries are exceedingly well adapted for bottling and preserving in various other ways. It is extensively grown for market, the planting of bushes in the spaces between rows of standard fruit trees being a favourite plan; indeed, the commercial cultivation of the Gooseberry certainly verges upon being overdone, and in seasons when there is a heavy crop, even where the berries are picked by women at a very cheap rate, the prices returned to growers are so low that the margin of profit is quite a small one.

Propagation is usually effected by cuttings, which root very readily if inserted 4 in. or 5 in. deep in early autumn in the open ground. Firm, short-jointed shoots of the current season's growth should be selected, 15 in. to 18 in. being the most suitable length. The buds and spines are removed with the exception of four at the top, the result being the securing a year afterwards of sturdy little bushes with 6 in. to 9 in. of bare stem, above which are stout leading branches about 1 ft. long, which should then be shortened by from one-third to one-half of this length. The pruning of Gooseberries is a simple matter, neglect of which inevitably results in a thicket of undesirable growth, producing only small berries which are difficult to pick. A model Gooseberry bush has been described as having main branches thinly disposed, furnished throughout with vigorous fruiting spurs, and maintained so by the annual extension and addition of young wood. Summer pruning, by which is meant pinching out the ends of the superfluous young shoots in June, and leaving only two or three pairs of leaves upon them, is a great aid towards this end; but this is frequently neglected. Extra large fruits are obtained by severe thinning as soon as the berries are set. The production of giant Gooseberries used to be a favourite subject for competition, enormous pains and much cleverness being expended in the production of sensational berries; other things being equal, the best results in this particular are obtained from young bushes with very few branches. Gooseberries are usually cultivated upon the bush system; but there is much to be said in favour of rows of cordon plants, indeed it would be hard to name a more profitable fence. They should be planted 6 in. apart for single cordons, or at three times that distance for plants with three stems. Cordons have also the advantage that the fruit buds and ripe berries suffer less from the attacks of birds. Bullfinches, sparrows, &c., are unfortunately exceedingly partial to the fruit buds; where their depredations are severe we have found it a good plan to bundle up the branches in autumn with some bracken amongst them. Another method is to spray with some adhesive solution distasteful to the birds, but this is rather troublesome. When in a plantation the bushes should be planted 6 ft. apart each way and in quincunx form, it being advisable to allow rather more than this distance where the soil is particularly rich. Gooseberries are also grown in pots under glass for the production of extra early and fine berries, but this is only done in wealthy establishments. Gooseberries can be cultivated with fair success in almost any garden soil. A good medium loam is the most suitable, with plenty of stable manure; an annual surface dressing in autumn should always be afforded. Other important cultural details are to keep the ground always clean of weeds by hoeing, and to avoid root injury by injudicious digging.



Cordon Gooseberries

The Gooseberry is very liable to the attacks of several insects that destroy the leaves, prominent among these being the caterpillars of the Magpie Moth (*Abraxas grossulariata*) and V-Moth, and the larvæ of the Gooseberry and Currant Sawfly (*Nematus Ribesii*). Short of hand-picking, syringing the bushes with water

and then dusting them and also the surrounding earth over with flowers of sulphur or lime is the best remedy, it being dangerous to use poisonous insecticides on fruit. The Red-legged Garden Weevil (*Otiorhynchus linetricosus*) is also sometimes destructive to the roots. Other insect enemies are *Ægeria tipuliformis* (Currant Clearwing), *Lecanium persicæ* var. *sarothamni* (Gooseberry Brown Scale). Considerable alarm has lately been occasioned by the detection of the American Gooseberry Mildew (*Sphærotheca morsuvæ*) in this country, and legislation has been enacted with a view to preventing its spread.

The very numerous varieties are divided into two classes, those with yellow and those with red skins. The former are the earliest to ripen, and they are generally held to be the most delicate flavoured, and the latter possess the best keeping qualities. Early Sulphur is the first to ripen, while Red Champagne and Golden Gem are particularly good dessert sorts. Whinham's Industry, Keepsake, and Lancashire Lad are great favourites with market growers for picking while green. There is a spineless variety, but it is not widely grown. [W. W.]

Gooseberry.—Parasitic Fungi.—

POWDERY MILDEW.—Two forms occur in Britain —European Gooseberry Mildew (*Microsphæra grossulariæ*), and a more recent introduction, the American (*Sphærotheca mors-uvæ*). The life-history of both species is somewhat similar, but they differ in microscopic structure and in injuriousness. A white mildew appears on green parts of the plant and produces summer sporules as chains of conidia, easily dispersed and capable of spreading the disease rapidly; later in summer the mildew patches become darker from formation of numerous black or brown ascus-fruits, some of which fall with the leaves and fruits, others remaining attached to twigs. See also ROSE—PARASITIC FUNGI.

The distinctions (Leaflet Agricultural College, Wye, 1907, with illustrations) are:—

(*a*) European mildew occurs on leaves, rarely on berries or young wood; found on full-grown leaves about midsummer; patches of mould scattered, if numerous the leaf turns yellow and falls prematurely; most prevalent when warm weather succeeded by cold spell.

(*b*) American mildew is seen earlier (end of May), on young leaves and berries; it spreads rapidly over leaves, tips of shoots and fruits, the latter being stunted and distorted, and coated with a brown scurfy crust (see plate).

The American mildew is thus the more injurious, and although only observed in Europe in 1900 it has spread rapidly in Ireland and south of England, and is very destructive in America. It is now a notifiable disease under the Destructive Insects and Pests Act, and restrictions are in force against import of foreign bushes.

Treatment.—For American mildew, dig up and destroy infected bushes. The disease may be checked by burning fallen leaves, and by close pruning and burning of mildewed shoots. Summer spraying with potassium sulphide (3 to 5 oz. in 10 gal. of water) is only a preventive for American mildew, but is a good remedy for European; first spraying when buds begin to unfold, other applications at intervals of a fortnight.

CLUSTER CUPS (*Æcidium grossulariæ*): æcidium cups on Gooseberry, uredospores and teleutospores on some Sedges (see FUNGI, 'Rust Fungi'). The berries are most severely attacked, the foliage less so. The cluster cups occupy a red or orange patch, and give off numerous orange spores. *Treatment.*—All affected berries should be collected and burnt, also all dead leaves and prunings. Spray fluids cannot be recommended on fruit nearly ripe.

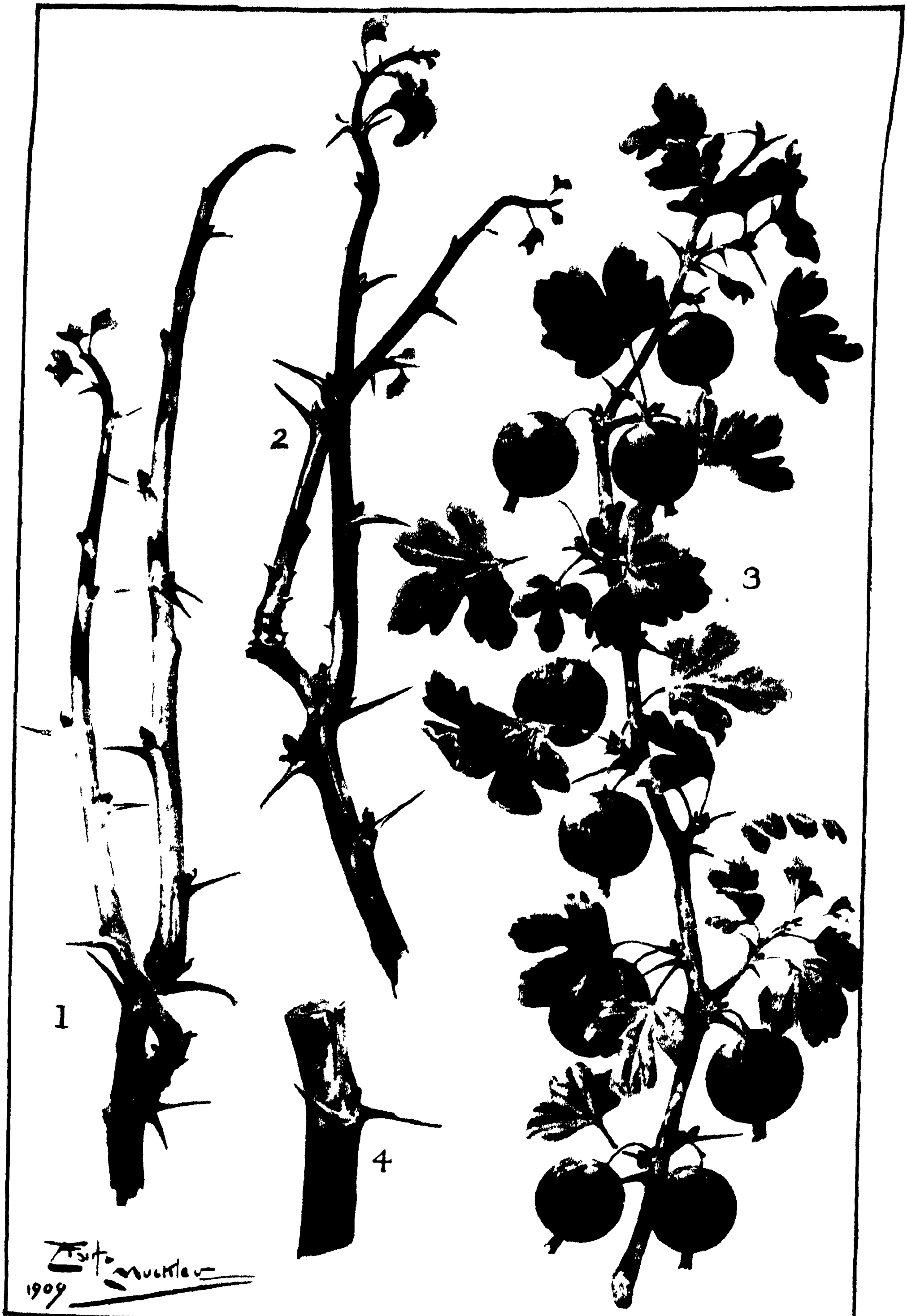
LEAF SPOTS.—Several forms occur on Currant and Gooseberry; these include anthracnose and leaf rust (see CURRANT, PARASITIC FUNGI). Another fungus (*Coniothyrium*), which accompanies premature leaf-fall and defective fruiting, has been observed. [W. G. S.]

Goosefoot.—Goosefoot (Chenopodium) is a genus of annual and perennial dicotyledonous

Goosefoot (*Chenopodium album*)

weeds giving its name to the whole order of plants called Goosefoots or Chenopodiaceæ. The leaves are alternate, without basal outgrowths (exstipulate), and powdered over with mealy-looking hairs. The flowers are inconspicuous, small and green, being destitute of petals, and each can produce but one seed. Common Goosefoot, White Goosefoot, or Meldweed (*Chenopodium album*) is a tough, erect, mealy annual weed of sandy fields. Its height is about 2 ft., and its leaf-blades egg-shaped or rhomboid, with a margin angular or toothed. The flowers are numerous and small, arranged in terminal

AMERICAN GOOSEBERRY MILDEW



1 Winter condition of shoots of green fruited Gooseberry 2 Winter condition of shoots of red fruited Gooseberry (Lancashire Lad) 3 Branch showing leaves wood and fruit attacked with American Gooseberry Mildew 4 Portion of shoot enlarged showing the winter fruit of the fungus.

spikes. The round flat seed has a black skin, and contains a mealy substance round which the embryo forms a ring. Being an annual, this weed is easily exterminated when seeding is prevented. A species much cultivated in Peru and Chile for the sake of its seeds is Green Quinoa Goosefoot (*Chenopodium Quinoa*, W.). The seeds are boiled like rice, and the gruel-like product is seasoned with Chile pepper and other condiments. Sometimes the seeds are roasted like coffee and then boiled with water. When seasoned, the brown fluid strained from the seeds forms a favourite dish with the ladies of Lima. [A. N. M'A.]

Goosegrass, an annual weed (not in the least like a grass) with weak, straggling stem covered with small hooked prickles, commonly found in hedges. See CLEAVERS.

Gopher, a popular name applied to various North American rodents belonging to the families Geomyidæ and Sciuridæ. The gophers of the first family, such as the Pouched Gopher (*Geomys bursarius*) and the Pocket-Rat (*Thomomys talpoides*), are thoroughly subterranean animals, very stout, with strong fore limbs, blunt head, no distinct neck, rudimentary ears, small eyes, and a thick tail much shorter than the body. Large cheek-pouches, opening from the mouth outwards, are used for holding food. The gophers burrow like moles, and 'their interminable mining operations are peculiarly disastrous to the agriculturist'. They are alert and quick in their movements, hardy, vicious animals, and very difficult to eradicate. Their food consists of roots and other parts of plants, which are often stored underground. Almost equally troublesome in some parts of North America are the ground squirrels (Spermophilus), closely related to prairie-dogs (Cynomys) and of similar habits. [J. A. T.]

Gorgonzola Cheese. — Amongst the famous cheeses of Europe, Gorgonzola takes a high place. It is both widely known and highly esteemed.

Gorgonzola cheese might be called an Italian form of Stilton, so much are they alike in appearance when cut. They are both blue-moulded throughout, in streaks and patches, but the methods on which they are made are very different from each other. There is, in fact, no similarity of method between them, after coagulation of the milk; or even during coagulation, so far as time occupied is concerned. Milk for Gorgonzola cheese is rapidly coagulated, milk for Stilton cheese slowly. The coagulum for Gorgonzola is broken down—slightly and slowly, it is true, but still broken; the coagulum for Stilton is not broken at all. The curd in Gorgonzola, having been broken, sinks to the bottom of the cheese kettle; the curd in Stilton does not sink, because it is not broken down. The liberated whey in Gorgonzola is ladled off, when it is well clear of the curd; in Stilton it is seldom ladled off the curd, but—at a later period — drains itself away. In the one it is the separated whey that is ladled; in the other it is the curd and whey together, before they have separated. In the Gorgonzola, the curd separates from the whey within two hours or so after coagulation has been completed, and is wholly removed; in the Stilton the whey escapes slowly, and has not wholly gone until several hours have elapsed. In the Gorgonzola, the process is almost as expeditious as in ordinary hard-cheese making in England; in the Stilton it is a slow and deliberate affair, the curd being left to its own devices in expelling the whey. Gorgonzola curd is got into the forms or moulds in about three hours after the coagulum has been broken down; Stilton curd, on the contrary, is seldom put into its hoops until ten or twelve hours have passed.

In the Gorgonzola process the whey is got rid of with all convenient celerity, and the curd is got into the moulds without loss of time. Before moulding begins the fresh curd is crumbled into pieces, and a thick layer of it is then put into the mould; next, a thin layer of the previous day's curd, also crumbled, is put in upon the other. And so on, in alternate layers of fresh and of stale curd, the mould is filled up, the first and last layers being always of fresh curd. The moulds are then left alone for six hours, when the upper portion of the cheese is loosened several inches deep, then covered with a cloth and turned upside down. In half a day's time after this, the cheese is similarly treated and again turned and put into the mould. In a day's time after this second turning, cloths are done without, fresh moulds are substituted, and the cheese is taken to a ripening room whose temperature is about 65° to 70° F., where it is deposited on a table that has a thin covering of straw. For the next three or four days the young cheese is turned over several times a day, at the end of which time the cheese can dispense with the mould, and is then placed for a day on a table that is strewn with salt, and is there turned over several times. It is then put back into the mould to preserve its shape, and this alternate treatment of being in the mould and out of it for a day is repeated for three or four weeks — longer or shorter, as may be deemed necessary. This stage of the process, a stage involving a good deal of trouble and attention, duly comes to an end, and the next—cellaring the cheese—commences, and goes on for six or eight weeks. During this time the cheese is turned, wiped with a cloth, and salted repeatedly, just as often as may be deemed necessary.

It will have been observed that, in the making of Gorgonzola cheese, the curd in one way or another is a good deal exposed to the air. This is done that the cheese may have an opportunity of attracting and absorbing a sufficient quantity of the spores of the fungus *penicillium glaucum* from the air around, and thus it acquires the blue mould which creates so striking a resemblance to Stilton cheese. From the earliest days of the Gorgonzola industry the curd was presumably so exposed, as it also was in the Stilton, but the makers had not any conception of the why and wherefore of the scientific problem which they solved in practice. [J. P. S.]

Gorse, a perennial bushy shrub furnished with sharp spines, which frequents heaths and moorlands. See WHIN.

Gortyna flavago (the Frosted Orange Moth).—The larva of the Frosted Orange Moth will attack tomatoes, tunnelling up the stems and so killing the plants. The moth varies from 1½ to 1⅞ in. across the expanded wings, the body nearly ⅝ in. long; upper wings orange-yellow, with three pale spots, and with pale-brownish marks running transversely across the wings, and the veins darkened; posterior wings pale-yellowish, with two dusky lines and distinct veins; thorax yellowish-brown; body paler yellowish-brown. Female larger than the male. Occurs on the wing in September and October. The young larva is dull dusky yellowish-white, with darker dusky transverse bands and black dots, anal segment dusky-brown; head chestnut-brown, first segment deep-brown; in the young stage there are four rows of black dots down the body. Later, the caterpillar becomes pale-dull-yellow; head deep-brown, first segment almost black, anal segment dusky, black dots on each segment more numerous; in the last stage the larva becomes slaty-grey with black dots. These caterpillars feed inside the stems until the end of June or mid-July, a few as late as August. When mature they are 1½ in. long. Pupation takes place inside the stems; the pupa is reddish-brown, and may remain for seven weeks before hatching.

The other food plants are Burdock, Ragwort, Water Betony, docks, thistles, and Verbascum. Hand-picking is all we can do to check the damage, and seeing that the attacked haulm is burnt. [F. V. T.]

Goshawk, a short-winged hawk of considerable size, formerly (and even still) used in falconry, but seldom seen now in this country.

Gouda Cheese.—The Gouda and the Edam are the two leading cheeses of the Netherlands. The former has its name from the town of Gouda, a few miles north of Rotterdam and in the Province of South Holland. It is a fresh- or sweet-milk cheese (*zoetemelksche kaas*), and also a full-milk cheese, which last appellation indicates a high degree of quality and condition if only the cheese be well made. The process under which it is made is marked by orderly cleanliness and unadorned simplicity, so characteristic of Dutch people in the rural districts of Holland, where dairying is pursued as an art and a business.

Milk devoted to cheesemaking is obtained from cows in a cleanly manner, which might be cited as an example worth emulating in various other dairying countries. It is poured into clean wooden tubs or copper kettles, and there renneted for coagulation, which takes up from forty to sixty minutes. The coagulum is gently and slowly disintegrated to admit of and to promote the separation of curd from whey, after which the curd is left for a few minutes to settle down and shrink. It is then stirred again, slowly and gently, until separation is sufficiently advanced, and the whey is ready for baling out.

The whey removed, heated water—or heated whey—is added, to increase the temperature of the curd, and is drained off again after a quarter of an hour. The curd is then thoroughly worked and stirred about by hand, and the remaining whey escapes. This done, it is cut into small pieces, rubbed or teased still smaller with the hands and fingers, and put into the moulds. These are put under pressure, light to begin with, and gradually increased during twenty-four hours. The cloths enclosing it are frequently changed, and the cheese turned each time, for a while at first.

The next stage of the process consists in immersing the young cheeses in brine contained in a trough. Here they remain a longer or shorter time—from three to five days, in accordance with the proportion of salt it is desired they should absorb from the brine, and from the salt which is scattered on the surface of each cheese when it has been turned over in the brine where it swims. When removed from the salt-bath, the cheeses are washed in warm whey, dried with a cloth, and placed on shelves in an airy and ventilated room free from draughts.

On the shelves they are turned each day for a while, then two or three times a week, and on each occasion wiped with a cloth dipped in warm whey, with the object of keeping the rind moist and to prevent cracks from developing in it. The cheeses are flat-sided, and their perimeter convex. They are made in different sizes and weights, varying from 8 or 10 lb. upwards to 15 or even 20 lb.

After a month or six weeks in press they are sold to the dealers in many cases, but sometimes are kept by the makers for a while longer, in which event they become ripe and are greatly improved in flavour. The dealers often keep them to ripen, and to obtain higher prices that more than compensate for loss of weight in ripening. They are, however, commonly eaten before they are ripe. This is when a brisk demand does not admit of ripening very far; and immature cheese is then accountable for much dyspepsia that would be avoided if the cheese had time to ripen. Dutch cheese is generally somewhat tough, owing to the way it is made, and it does not compare favourably with equally well-made English cheese of various kinds. [J. P. S.]

Gourd, the popular name for a large number of species and varieties of plants belonging to the Cucumber family. See PUMPKIN.

Gout Fly, the popular designation of the Ribbon-footed Corn Fly (*Chlorops tæniopus*). See CHLOROPS.

Goutweed, a common umbelliferous weed frequenting hedgerow, roadsides, and garden walks. See BISHOP'S WEED.

Gracilaria syringella (the Lilac Leaf Miner), a small moth whose caterpillars are very harmful to lilac in gardens and shrubberies. The moth belongs to the Tineinæ (Micro-lepidoptera), and is about ½ in. in wing expanse; the fore wings are silvery to creamy white, with bands of bright-brown, some angulated; apex mostly fuscous-brown, except for two small white spots near the edge; hind wings grey; legs grey to white, with brown specks. The moths fly about sunset first in May and June, and as a second brood in July and August. The first

brood lay their eggs in June in clusters on the leaves; in a week they hatch, and young caterpillars eat their way into the parenchyma and tunnel the leaf; as many as twelve may be found in one blister. The blisters are irregular, and later turn brown and die. The larvæ are semi-transparent, with the green chlorophyll showing through the skin, and have a brown head, the segments much indented; length, ¼ in. when mature. About ten days before they become mature they leave the blisters and crawl to the apex or side of other leaves and roll the leaves up, feeding in the rolls on the under epidermis, &c. They remain some days in the rolled leaves, and then seek shelter to pupate in, such as crevices of the old wood, where they spin a small white cocoon, from which the moths appear in from ten to sixteen days. The second brood works in a similar way to the first.

Treatment. — All diseased leaves should be picked off in gardens and nurseries. The old wood may also be washed with caustic alkali wash in winter. [F. V. T.]

Grades and Grade-breeding of Cattle. — Grade is a very useful term, better known in America than in this country, and descriptive of an animal, one only of whose parents is pure-bred. A Galloway grade, for example, is the progeny of a Galloway bull and a cow that cannot be assigned to any recognized breed, and a herd of grade Shorthorns is one in which the sire was a Shorthorn bull and the cows were nondescript. 'Grading up' or grade-breeding is a cheap way of forming a pure-bred herd, and on account of the difficulty of importing pedigree females is frequently adopted in America with excellent results. The famous Booth line of Shorthorns was formed by selecting in the local market good cows of unknown breeding, and mating them and their progeny of successive generations with pure-bred bulls. In a new, thinly populated country, or in remote districts of the British Isles, this method is most satisfactory if the sires are well chosen and the heifer calves retained for breeding are of the right sort. It is, however, when function and not form is to be improved, such as the milk yield in cattle or the trotting pace of horses, that grading up proves most successful.

Improvement in quantity or quality of milk, or both, can be rapidly accomplished by grading up, and a very valuable dairy herd evolved from cheap material. By recording the yield of milk, the worst milkers can be quickly eliminated, and by mating the best cows with bulls descended from known heavy milkers, the average yield of milk from the herd can be quickly raised. As an example, a milk-testing society in Sweden, in six years, by grading up its herds increased the milk yield from 670 gal. per cow to 876 gal., and the percentage of butter fat from 3·09 to 3·21. [R. B. G.]

Grading of Farm Produce. — That farm produce should be graded, that is, sorted out into grades or different qualities before being offered for sale, is as essential as in the case of other products that vary in their quality. The tanner would never think of throwing the whole of his hides into a heap and selling them by the ton, nor would a potter offer the whole contents of his kiln without a very careful process of sorting. The essence of the whole matter is that certain classes of articles suit particular kinds of buyers; there are those who will have the best, there are those who must have the inferior, but there is practically nobody who wants all kinds jumbled together; and experience has shown that by sorting out the qualities to suit the buyers, better prices are made of the whole. This rule applies just as much to the products of the farm as to any others, but its importance does not seem to be generally realized.

It is true that the farmer has to contend with many difficulties in the grading of his produce, owing to the smallness of the bulk or the difficulties of separation, but it is probable he might grade with advantage far oftener than he does. He has learnt from experience that it is absurd to try to sell an obvious 'waster' with a bunch of healthy cattle, and no farmer with a shadow of business instinct would dream of mixing his gimmers or threaves with broken-mouthed ewes when exposing them for sale. There is no doubt that, as far as the size of his lots will allow, the farmer does grade his live stock, but there are other products to which grading might be applied with advantage.

Barley is a case in point. Nothing but an evenly ripened sample of good colour and free from dirt is of any use to the maltster, and for such samples he is willing to give a good price; but should the sample be uneven, dirty, or badly dressed it is useless to him, however good the colour, and it becomes a grinding barley with a much lower value. How can this be graded? In the first place, all laid, overripe, or unripe patches in the field should be cut out and carried to a separate stack. The rakings should never be used to top up a stack of good barley, as is often the case, for pieces of dirt are sure to appear in the sample. The stack should stand long enough for the whole to have become equally dry throughout, otherwise in hummeling some of the kernels will have the awns left on, while others are skinned. The barley should then be well blown and dressed, so as not only to remove the weed seeds, but also to remove all kernels below the average size. These smaller grains are in nearly every case imperfectly ripened, and would not only spoil the appearance of the sample, but injure its malting quality. The result of this thorough dressing may be to reduce the bulk by 20 per cent or more, but the tailings are still a useful grinding barley, and the bulk will realize a higher price.

Oats should be treated in a somewhat similar way, being well clipped in the hummeler, and then thoroughly dressed to remove not only the light grains, but the small and the extra large as well. With grain of all kinds a great deal more care than is usually given should be exercised in removing all damp and grown kernels, even if it means the sacrifice of the whole roof of the stack, for many a sample is completely ruined by a very small percentage of damp grain, which could easily have been profitably used at home.

Wool is another product upon which much money is lost every year for want of grading.

The colonial farmers are exceedingly careful in the grading of their wools, and the good prices realized for their wools are not a little due to this cause. No manufacturer wants mixed wools; his business usually demands a particular quality—it may be the finest or the poorest, but no other grade is of any use to him, and if he buys mixed wools he buys them at such a price as will enable him to dispose of what he does not require at a profit. The most important point in the grading of wools is the staple, and fleeces of the same length of fibre and fineness should be put together. Ewe wool should be packed separately, and the greatest care should be taken to see that all pieces of grass or straw are picked out, as well as all tag-locks and patches that are badly stained. There is a market for this dirty wool at a price, but very few people want it; and it is an unfortunate fact that so badly have buyers been deceived in the past, that they make a much greater allowance in price for dirt than is necessary in most cases, and the many suffer for the sins of the few.

The large farmer with his thousands of fleeces has little excuse for not grading, but with wool as with many other products of the smaller farmers, each one has not a sufficient quantity to make accurate grading a possibility. For such farmers co-operation is an essential, and it is possible to conceive a co-operative society amongst the farmers of a particular district so grading and packing their wool as to realize prices at least equal to those obtained for colonial wools of the same quality.

This co-operation for the sale of properly graded produce has been brought to a high state of perfection in many parts of the Continent, and there are several successful examples of it in this country. The bacon, butter, and eggs received from Denmark and France are examples of co-operative production, grading, and sale; while we have in this country a society in the east of England that grades barley and other corn for its members, besides selling pigs, poultry, eggs, and other products; several societies that devote themselves principally to the grading of eggs; some in Wales that grade, blend, and pack their members' butter, others in different places that grade and sell their members' fruit and vegetables. It would be interesting to mention all the methods pursued by these societies in placing their produce on the market in the most attractive and profitable manner, but space forbids more than the mention of one or two. It is well known that the British egg as generally found in shops is not by a long way the type of freshness and reliability. This is not only due to the fact that the eggs are not looked up with sufficient care and regularity, but because, the quantity being comparatively small, they cannot be marketed more than about once a week. In a co-operative egg-grading society the eggs are collected, or delivery is insisted upon, at least two or three times a week. Immediately the eggs are received at the depot they are passed over an egg-tester and all stale or cracked eggs are rejected. Those that have passed the test are then sorted into sizes, packed in boxes or crates, and despatched the same day. The result is that these eggs gain a reputation for reliability, the demand in most cases exceeds the supply, and prices are considerably enhanced. Fruit is now being dealt with in a somewhat similar way, with the result that each buyer can have exactly the grade that suits his particular business. The best qualities of such fruits as apples and pears, when carefully selected and packed in tissue paper in small boxes, realize exceedingly high prices, while there is also a good demand for sound fruit of a second quality. It is probable that in many cases the first-grade fruit alone out of an ordinary consignment will realize as much as the whole consignment would have done when marketed in the usual way, in which all kinds or qualities are mixed together. Both on the Continent and in the New World our competitors are teaching us much in the way of putting our produce on the market in its most attractive form; and although a good many British farmers still continue to market their produce just as their grandfathers did when locomotion was both slow and expensive, the presence of a considerable quantity of graded British produce on our markets shows that the farmer is waking up. [W. M. T.]

Grafting.—This is an operation in which two cut surfaces of the stems of the same species or of different species of plants are placed so as to unite and grow together, its object being to modify in some way the growth or behaviour of the upper portion, or scion, by the influence upon it of the lower portion, called the stock. When the parts have become united there is perfect continuity between the two, yet the specific characters of neither are appreciably affected by the interchange of juices (food). Thus if a peach shoot is grafted on the rooted stem of a plum, the shoot continues to develop only peach leaves, flowers, and fruits as long as it lives; and if a shoot of the plum stock were allowed to grow, even after twenty years' union with the peach it would be found to produce only the normal leaves, flowers, and fruits of a plum. There have been a few recorded instances of the stock having been slightly altered in character by the scion, but they do not affect the general principle. The anomalous graft-hybrid known as *Cytisus Adami* is the only known instance, notwithstanding the many millions of plants that have been grafted, in which a mingling of cells has taken place and resulted in a fusion of the characters of stock with scion.

There is an adhesion of parts, a passage of fluid from stock to scion and from scion to stock, and this has a modifying influence on growth. If the stock is a more vigorous grower than the scion it will communicate some of its vigour to the scion, and vice versa. This fact has been largely turned to account by gardeners, and grafting is very largely practised in the propagation of many kinds of trees, shrubs, &c. Practically all the named varieties of fruit-trees, viz. apples, pears, plums, cherries, peaches, and, in the case of the best varieties, oranges, mangoes, cocoa, &c., are multiplied by means of grafting (or a form of it, known as budding); likewise the best roses, rhododendrons, and many other decorative plants. The best application

of the art of grafting, by means of which an important European industry, namely, grape growing, was saved from destruction by phylloxera, an insect which attacks the roots of the common grape vine, was the use of another species of Vitis, immune to the attacks of this louse, as a stock on which the grape vine was successfully grafted.

There are various modes of grafting. The principle is shown in fig. 1, A being the scion, B the stock. The best results are secured by employing stock and scion of the same thickness, so that there is a complete union all round; but if the stock is thicker than the scion, then the latter must be placed so that its bark at the base and on one side is in contact with that of the stock. The two are then bound together, and the binding covered with clay or grafting-wax

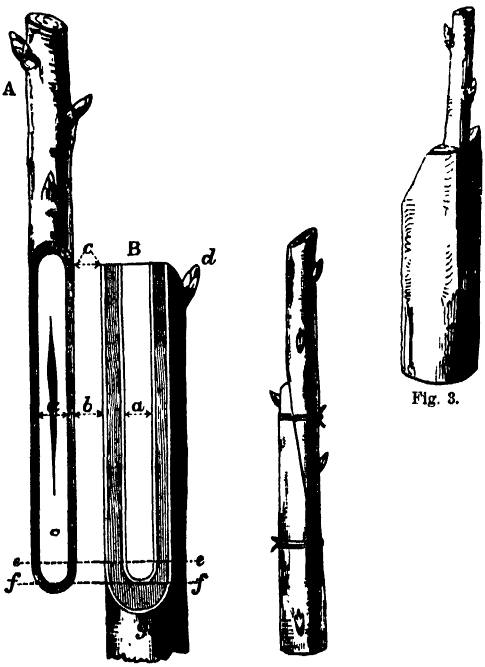


Fig. 1.—Whip-grafting

Fig. 2.

Fig. 3.

to keep out water and air until a union has been effected. Other forms of grafting are shown in figs. 2 and 3.

Budding is a form of grafting in which the scion consists of only a portion of the bark with a bud. This is inserted underneath the bark of the stock by slitting and raising the latter (see BUDDING). The art and principles of grafting are understood by expert gardeners. The operation is one requiring skill and experience, as well as a knowledge of the affinities and habits of the plants operated upon. Only plants that are closely related to each other can be successfully grafted. Unfortunately this is not always recognized, and grafting as a useful garden art has in consequence fallen into ill repute.

[W. W.]

Grain, a general term used in agriculture for the fruits (caryopses) of those crops which furnish the staple food of man. The term thus refers in this country to the grain produce of the four cereal crops, wheat, barley, oats, and rye. In America, maize and rice are also included. The cereal grains are especially characterized by their richness in carbohydrates, notably starch. The proportion of carbohydrates ranges from about 50 to 60 per cent in oats up to about 65 to 75 per cent in the 'naked' grains (wheat, rye, maize). The proportion of albuminoids ranges generally from about 8 to 10 per cent in malting barley up to about 11 to 13 per cent in wheat. Oats and maize are further characterized by the presence of an appreciable proportion (4 to 7 per cent) of oil. The albuminoid ratio usually ranges from about 1 : 7 (oats) to 1 : 10 (maize, barley). Most of the starch and a considerable proportion of the albuminoid matter is contained in the endosperm. This is enclosed in fibrous coatings, the number, nature, and thickness of which vary in the different grains. The total amount of these coatings ranges from about 26 per cent of the whole grain in the case of the oat, down to less than 1 per cent in the case of wheat, rye, and maize. Owing to their fairly concentrated and digestible nature, the grains and the 'offals' (bran, sharps, &c.) obtained from them in the milling process form the most widely used, and in many ways the most important of foods. See arts. BARLEY, OATS, &c.

[C. C.]

Grain, Milling of. See MILLING.

Grain Drills. See DRILLS.

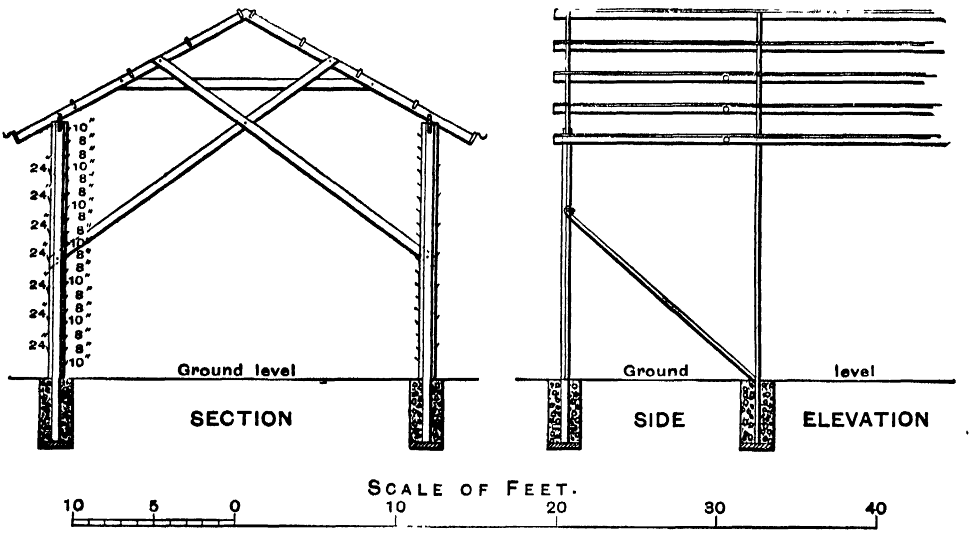
Grain-drying Sheds and Racks.— Many attempts have been made to dry cereals by artificial means. In late and wet districts it has long been the custom to build grain in stacks of 'sow' shape on timber, and even dry stone dykes and hedges have been utilized for this purpose. In recent years those devices for securing the passage of a drying current through stacks of sheaves have undergone considerable development, and at present at least two efficient grain-drying racks are before the public. There is the form invented by Mr. John Richmond of Dron, Perthshire, known as the Richmond rack, with a modification of it, which consists of a Richmond rack and a shed comparable to a Dutch barn; and the rack invented jointly in 1907 by the Rev. John M'Ainsh, B.D., and Mr. Chas. Robertson, Strathbraan, Perthshire, which was shown at the Highland and Agricultural Society's Show in 1908.

The Richmond rack consists of two sides 5 ft. apart, which are made up of two straining posts, one at each end, with intermediate posts 4 ft. apart. Each of these rows of posts carry two systems of wire, an outer and an inner, which are strained and suspended so that they can be packed with sheaves, which are supported by the wires, so that one layer does not rest or press on that underneath. Thus the sheaves are kept free and open, and dry readily. The rack, which may be any length, is usually built 100 to 130 yd. long, and stands 16 ft. high. It is covered by a corrugated iron roof, and owing to the large surface exposure requires to be well anchored to the ground.

What is claimed to be an improved form of the Richmond rack was erected at Glenormiston, Peeblesshire, in 1907. This 'Improved Grain-drying Shed' is essentially a Richmond rack, but the two sides are 24 ft. apart, and consequently a large space is provided between the two tiers of sheaves, and this space being under cover, forms a shed or Dutch barn and a Richmond rack all in one.

It is claimed for both of these racks, that in addition to saving grain and straw in a bad season, grain can be cut, carted, and secured the same day, and even wet grain may be put into the rack to dry; and that the grain gets into 'condition' quickly. Moreover, no thatch, ropes, props, or bosses are required, and the moving of stooks in bad weather is obviated.

On the other hand, it cannot be said that the Richmond rack has so far received a large amount of appreciation from agriculturists, except in particularly humid districts and in situations where the fields are much sheltered by woods. The practical drawbacks are that the work of filling the rack is much slower than in stacking, besides requiring an extra hand, and the frequent emptying and refilling necessary, unless a very large rack is available, means much handling and loss of time and grain; while,



Grain-drying Rack at Glenormiston, Peeblesshire

if the sheaves be left in it for the greater part of the season and not stacked, the straw becomes too dry and brittle to be palatable fodder. Another drawback in practice is the difficulty of adequate protection from birds. But while all this may be true, there is little doubt that an extension of the system of putting up grain in racks would on the whole be beneficial.

The M'Ainsh-Robertson rack differs from that already described in being collapsible and portable, and in having no roof. The grain put upon it is built and headed out into a 'sow'-shaped stack and thatched in the ordinary way. The structure consists of supporting frames set vertically across the sow-stack at intervals of 15 ft. On these rest the ends of horizontal battens on which the grain is built, the weight of five rows of sheaves being supported on each set of battens. This rack is really a systematic, simple, and efficient method of arranging timber on which to build and dry grain. The cross bars, the longitudinal bars, and the air vents are so arranged that sheaves are kept in position, that top pressure is relieved, and sufficient air circulation is permitted to dry and preserve the crop in good condition without causing it to become too brittle. It is claimed for this rack also that the crop can be stacked right off without being stooked. It has the merit of being simple, easily constructed, and portable. The initial cost is about 28*s.* per acre of crop, but the structure should last for many years, and as the bars are 4 in. by 2 in. and the battens 15 ft. long, they can be readily diverted to other purposes if desired. [W. Bru.]

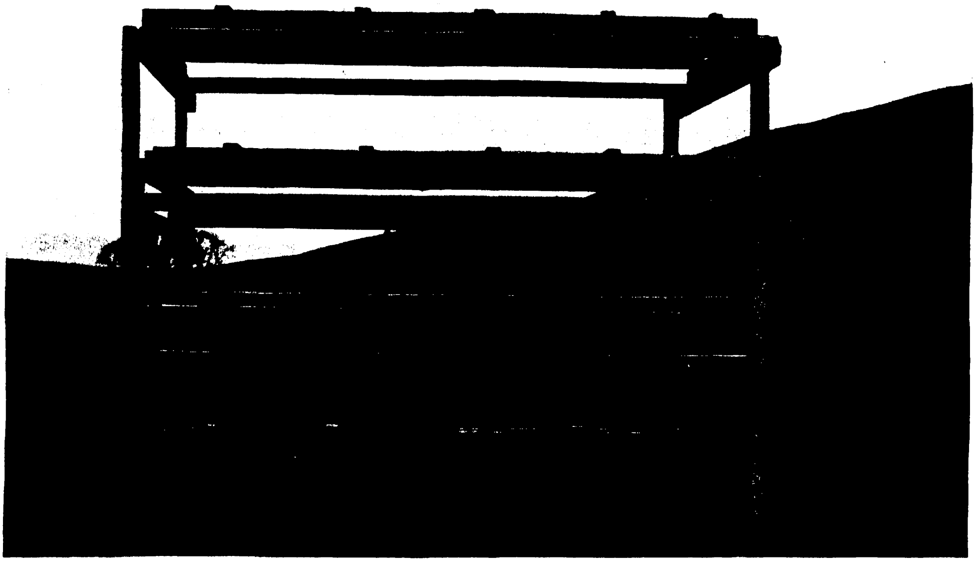
Grain Rent, rent paid in kind: a common custom followed when money was scarcer. See Rent.

Grain Weevil, a small beetle which does great destruction in stored grain or malt. See Calandra.

Graip.—Graips, or stout forks with three or more tines, are used for many purposes on the farm. They differ from ordinary hay forks in that they have a square tread to enable the user to force them into ground or other hard material by the aid of the foot. Though sometimes made with long handles, a short spade handle or helve with a pronounced bend at the socket is the best type. See Forks.

[W. J. M.]

Gram (*Cicer arietinum*) is a leguminous plant indigenous to India. Its seed is now imported into Great Britain in increasing quantities as a cattle food. It is rich in proteids, as the following analysis will show:—



M'AINSH-ROBERTSON GRAIN DRYING RACK
SHOWING FRAMEWORK AS IT IS INSIDE FINISHED STACK

M'AINSH-ROBERTSON GRAIN DRYING RACK
SHOWING COMPLETED STACK RESTING ON FRAMEWORK

	Percentage composition.	
	Gram.	Peas.
Proteids	21·6	25·4
Ethereal extract	4·6	3·4
Digestible carbohydrates ..	51·2	52·2
Fibre	10·0	4·6
Ash	2·8	3·0
Moisture	9·8	11·4
	100·0	100·0

Compared with the analysis of peas, it appears to be of nearly equal feeding value. It is a little poorer in proteids and contains more fibre. It is said to give very good results with dairy cows, when used for replacing beans and peas in a ration. It is cheaper than the latter foods, and is not as yet widely known. [R. A. B.]

Gramineæ. See GRASSES.

Granary.—This is auxiliary to the barn, and consequently more or less central as regards the other buildings of the homestead. Wherever it is possible the granary is placed overhead, grain keeping better in such a position in our damp climate than it does on a ground floor. The granary is more or less a part of the commissariat department of the homestead. Chief, however, among its duties is the storage of grain between the time it is threshed out and its delivery to the purchaser. But if fitted up suitably for the one purpose it answers for the other. At some farms there is very little holding over of grain, therefore not much call for granary accommodation. At most, however, there is increasing call for room of this sort for commodities that are to be consumed at the place. The simpler the granary is arranged as regards construction of walls and roof, the more effective will it be. Usually the want of contrivances to save labour in handling the stuff being stored in the farm granary betrays the lack of inventive faculty in this respect on the part of the agriculturist. It is for the estate manager, however, to construct the building in such a way that it can perform its end to the best advantage, irrespective of how the occupier may set about handling the stuff it is intended to hold. It must of course be judiciously placed in relation to the other buildings. A good strong floor (whether it be of wood or of concrete) is the first essential. We have witnessed the collapse of a granary floor with its load of oats on to the floor beneath, through non-attendance to this point. There is no need to have the side walls of the buildings more than 5 ft. 6 in. above the level of the granary floor. The roof is almost certain to be of the couple type (see ROOFS), in which case, with the ties at 18 in. above wall-head level, we get a clear head-room of 7 ft. In every case the wall-heads should be filled in, that is to say, the angle between the top of the wall and the roof boards should be built up. If this be left open it is simply a gathering place for dust and rubbish. We believe in lining the face of the walls with wood. If straps be built in the wall for the purpose, there is nothing to do but to secure the boards to these. A good plan is to set these straps with a projection of half an inch or so beyond the face of the wall, and before lining with wood to plaster the wall with cement flush with these straps, after which neither mouse nor rat can work behind the boards. With side walls finished in this way, one can heap grain against either or both, as well as along the centre of the floor. And there is no reason why there should not be air inlets along both sides. With these adjustable by hand, one could control draughts through the place; and if properly guarded with perforated zinc they would suffer no harm from a heap of grain lying against them, while the grain would be all the better for the air they passed into it. We would have the light by way of the roof through hinged skylights capable of being thrown wide open and thereby admitting of the exit of dust at one time and the entrance of fresh air at another. And on the ridge we have zinc ventilators fitted up for the purpose of keeping the air within the building on the move at all times. The aforementioned particulars, together with the planing of all the roof wood exposed to view, give a place as useful as may be wished for, and at little more cost than the crude-looking places we so often see being put to service in this connection. [R. H.]

Granite.—This is probably the most widely diffused igneous rock in the crust or outermost shell of the earth. It contains some 72 per cent of silica, and quartz is consequently an important constituent in it. Orthoclase or microcline felspar is an essential, and 8 per cent of potash is frequently present. Soda-lime felspars are almost always found, in varying proportions. Some of the potash may occur in the muscovite mica, which is the common third constituent. Biotite (dark mica), also containing potash, and even hornblende may be present. The rock is completely crystalline, having cooled a long way below the surface, and it has subsequently become exposed by denudation. It sends off veins into surrounding rocks, and may alter clayey sediments over wide areas into crystalline schists, and limestones into crystalline marbles. Most granites now exposed on the surface were consolidated in early geological periods; but those of the Red Hills of Skye, of central Mull and Arran, and of the Mourne Mountains, are of post-Cretaceous age. Very many granites in our islands, like those of the Leinster Chain and of the Southern Uplands of Scotland, are post-Silurian and early Devonian.

Very often, by subterranean action, masses of granite have become altered before being exposed upon the surface. The felspars have become largely replaced by minutely developed potash-mica, or by powdery kaolin. When denudation reaches the mass, these decaying felspars are readily washed out, the kaolin going away as a fine clay; the quartz and original mica remain behind, with broken-down felspars, as a coarse sand. The same process also goes on slowly at the surface, under the influence of the carbon dioxide of atmospheric waters. The acid action of a layer of peat similarly rots the granite rock beneath it, and granite long exposed to permeating waters may be quite soft and friable to a depth of several feet from the surface. Projecting masses of granite weather along their joints, which are often tabular or

broadly curving; and the crumbling that goes on along these surfaces causes the solid rock to break up into a mere pile of blocks and boulders. Such is the origin of the rough 'clatters' of Dartmoor, and a great number of stones have usually to be removed by blasting before a granite area can be cultivated. Granite areas often form high moorlands, since the rock comes up in the cores of mountain-folds and also resists weathering better than the sediments on each side. Yet, even when worn down to a more accessible level, the boulder-strewn ground, with its bare rock often visible over many square yards at a time, is suitable for little but rough pasture, or for the growth of coniferous timber that requires little depth of soil. [G. A. J. C.]

Granite Soils. — The soils derived from granite are of different types, varying according to the mineralogical composition of the rock, and to the situation in which the soils have been formed. When the formation occupies an elevated position, as it usually does, the soils are thin barren sands or gravels supporting a comparatively worthless vegetation, or overlain by a covering of peat. These sands or gravels are really the residue left after the finer materials have been washed out from the original rock detritus, and they contain crystals of all the constituents of granite and small fragments of the originating rock. The finer matter carried down by the rain-wash to the lower levels may form, at the foot of the granite hills, stretches of poor wet clays, which require liming and draining before they can be profitably used as arable land. Some granites, possessing felspar and quartz in fairly well-balanced proportions, weather down to loams of comparative fertility. Soils of this description are to be met with in Cornwall; they need but a dressing of lime to convert them into valuable wheat and barley lands. Chemically, granite soils are rich in potash, but generally poor in phosphoric acid and lime. Much of the potash shown on analysis remains long unavailable, owing to the slow decay of the felspar and mica in which it is locked up. [T. H.]

Grape. See Grape Vine.

Grapes, the popular designation of Grease, a malady which affects horses' legs. See Grease.

Grape Sugar. See Sugars.

Grape Vine (*Vitis vinifera*), the most important of the 250 species of Vitis (nat. ord. Ampelideæ), distributed mostly in the tropical and subtropical regions of the world. As now known, *V. vinifera* is a variable plant of scandent habit, the stems sometimes thick and woody at the base, the annual shoots long and more or less zigzag, and the leaves heart-shaped, lobed, smooth or hairy, and deciduous; flowers on short axillary peduncles, small, green or red-brown; fruit a berry of variable size and shape, black, green, or yellow when ripe, pulp juicy and edible; seeds several. Where the plant is wild it climbs up large trees to a considerable height and bears fruit freely. According to Vilmorin, the records of the cultivation of the vine for the making of wine go back 6000 years. It has varied so much that there are said to be about 2000 described varieties known. This variation has extended to constitutional hardiness, the wide range of temperatures in which the different forms may be successfully grown having no parallel among domesticated races of plants. Some are hardy in England, whilst others, like Muscat of Alexandria, require a tropical temperature to come to perfection. There is evidence that the vine was largely grown in the British Islands centuries ago as a hardy shrub for the sake of its fruits, and in South Wales to-day there is a vineyard in which grapes are grown for wine-making on the same principle as in southern Europe.

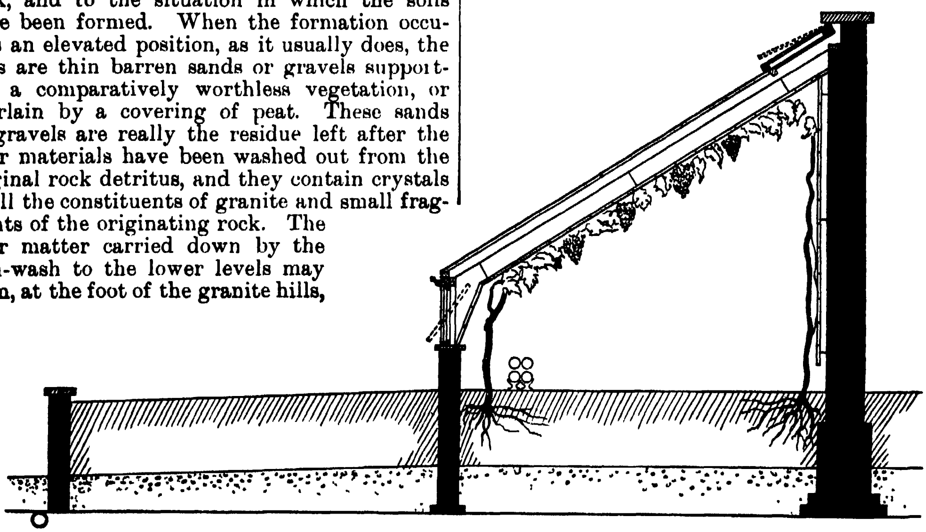


Fig 1 —Section of Lean-to Vinery, showing Border, &c.

In this country the grape vine is most valued as the producer of fruit of first-rate quality when grown under glass with treatment of a more or less forcing character. The art of grape growing is essentially a British one; in no country in the world can such high-class fruit be seen as that grown in private gardens in this country. It is true that the methods of the champion grape grower are expensive, but he has succeeded in showing that by devoting great care and skill to their cultivation, grape vines may be made to yield annually large crops of large, delicious berries, surpassing in their juiciness and flavour all other kinds of fruit. The art of grape growing as practised by the

most expert gardeners is on a higher plane than that of the ordinary growers. Fortunately the plant is so good-natured that with comparatively little attention, if only the essentials are present, it will grow and yield annually a crop of average fruit. These essentials are a sunny greenhouse, a border of good soil, and properly planted canes of varieties suitable for the purpose. Fig. 1 shows a lean-to vinery of the kind preferred by many grape growers. It is not necessary to have a border outside as well as inside, nor is it worth while to attempt to grow vines on the back wall of the house. A span-roofed house would be preferable if more space is required. The various operations necessary for the development of growth, flowers, and fruit are set forth in most books on gardening, including some which deal with vine culture only.

The best soil for the grape vine is a fibrous loam of somewhat clay-like consistency. To this should be added lime rubbish in the proportion of 1 to 6, and ½-in. bone manure in the proportion of 1 to 12. The border should be 3 ft. deep, with 6 in. of brick rubble as drainage. The vines should be planted 5 ft. apart in February. For fruit to ripen in September, they should be started to grow the first week in April by raising the temperature of the house to 60° F., increasing it to 70° when they show flower. In warm sunny weather the temperature may rise to 80° or more. Ventilation requires careful attention; generally the air should be kept fresh and buoyant, without risk of chill from draughts. Plenty of atmospheric moisture should be afforded from the start until the fruit begins to colour, and the plants syringed two or three times a day until the flowers expand, after which syringing must be discontinued. After the fruit has been gathered and the leaves have fallen, the house should be kept cool and airy. Pruning is of two kinds, spur and long-rod, the former being the cutting away of the annual lateral rods to within half an inch of their base, as shown in fig. 2. This is the method generally practised. The best varieties for cultivation under glass are: Alicante, Black Hambro, Foster's Seedling, Gros Colman, Madresfield Court, Muscat of Alexandria, and Mrs. Pince. For cultivation in the open air, Black Cluster, Miller's Burgundy, and Royal Muscadine are recommended. For an unheated greenhouse the most suitable variety is Black Hambro. [w. w.]

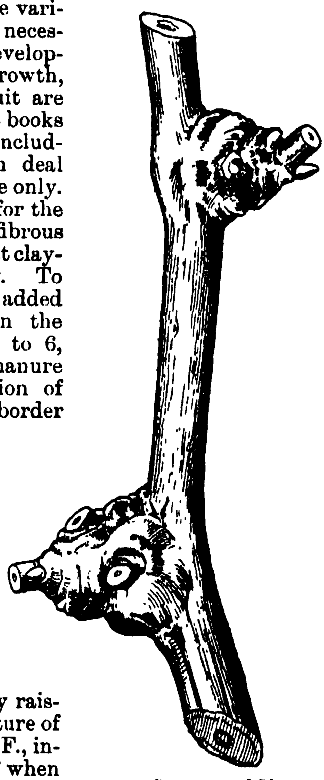


Fig. 2.—Spur-pruned Three-year-old Vine Stem

Grape Vine.—Fungus Diseases and Chlorosis.—

Powdery Mildew (*Uncinula spiralis* or *Oidium tuckeri*, fam. Erysipheæ, ord. Ascomycetes: see Fungi).—White or greyish mouldy patches on upper surface of leaves, and on other parts; discoloration follows slowly, and the leaves may fall off prematurely. Grapes with mildew swell irregularly and frequently split open. The winter ascus-fruit stage is rarely seen.

Treatment.—Flowers of sulphur, used as follows: (*a*) Dusted or blown over the foliage; (*b*) made into a paste with water, with or without addition of lime, and painted over heating pipes of greenhouse; (*c*) heated in a large pan, taking care that it does not take fire. A hot-water method is also recommended (Gardeners' Chronicle, May 27, 1899). Spray fluids used for other fungi are also effective.

Downy Mildew (*Plasmopara viticola*, ord. Phycomycetes: see Fungi).—This resembles the last, but the white covering is more transparent. Leaves when attacked become rapidly discoloured and fall prematurely. If the attack is severe the fruit does not swell, and the plant is impoverished for next season. The life-history is illustrated in art. Fungi.

Black Rot or Anthracnose (*Glœosporium ampelophagum*).—This appears on grapes as sharply defined rounded spots, at first brown, later with a brown margin and an ash-grey centre; the damage penetrates deeply, and the grapes shrivel up. Similar spots appear on the leaves, and frequently fall out, leaving holes. The minute sporules are given off from small cavities.

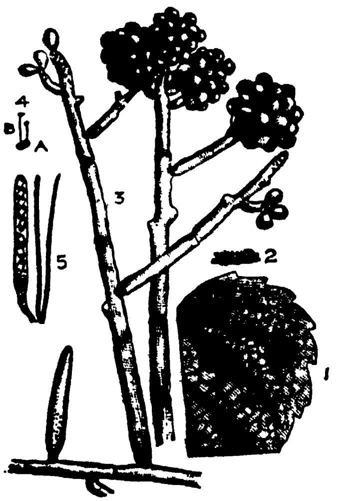
Treatment for Leaf and Fruit Fungi.—All forms of spot or mildew are checked or destroyed by Bordeaux mixture of medium strength (see Fungicides); apply before buds open, again after flowering, and repeat in fourteen days. If later spraying is deemed necessary, cupram is preferable, as it does not disfigure the fruit. During the resting period, stems should be washed with some solution containing iron sulphate.

Sclerotium Disease (*Sclerotinia fuckeliana*).—Stages of the life-history (see fig.): (*a*) velvety olive-brown mould on fading leaves, shoots, and fruits—from this abundant sporules are given off; (*b*) sclerotia, minute tuberous black masses of resting fungus filaments, on dead remains of vine; (*c*) ascus-fruits (peziza-cups) produced from sclerotia and giving off ascospores. The fungus is very common on faded leaves and flowers of many greenhouse plants, generally as a saprophyte, but also becoming parasitic. An allied species causes clover sickness (see that article).

Treatment.—Increase ventilation and decrease moisture of greenhouse. During the resting season, remove top few inches of soil, and wash the house with lime. Bordeaux mixture is also recommended.

Chlorosis or yellow leaf is due to lack of avail-

able iron in soil; it is common on calcareous soils. Successful treatment by a vine grower recently came under our notice: holes were bored in the stems, filled with iron sulphate, and plugged up; in a few weeks the leaves became green, and a



Brown Vine Mildew (*Sclerotinia fuckeliana*)

1, Summer fruit on portion of a Vine leaf (reduced in size). 2, Summer fruit (natural size). 3, Portion of summer fruit (magnified 300). 4, Winter fruit springing from a small black sclerotium (natural size). 5, Mode of spore formation in winter fruit (magnified 200). (*Journal Royal Horticultural Society*.)

good crop was secured. The disease is not confined to the vine, and may appear in orchards.

'Shanking' or premature fall of grapes, 'gummosis', which attacks woody stems, and 'browning' of foliage are obscure diseases, generally due to defects in cultivation. [W. G. S.]

Grapholitha pisana (the Pea Moth or Maggot).—In June these moths appear, and the

Grapholitha pisana (Pea Maggot, Moth)

1, 2, Caterpillar, nat. size and magnified; 3, 4, moth, nat. size and magnified.

female deposits her eggs in the blossom and upon the young pea-pods; the caterpillars from them eat into the peas, and thus they become 'maggoty'. The caterpillars are pale-yellow, with a few scattered hairs and three lines of brown dots down each side, being about eight on each segment; the head is black, as well as two large patches behind it, and the six pectoral legs; the eight abdominal and two anal feet are fleshy. Fig. 1 shows the caterpillar on a pea which it has eaten, throwing out the excrement. The caterpillars spin a fine cocoon in the earth, within which they change to pupæ in the spring, and the moths hatch in June; the wing expanse is seven lines, the wings being mouse-coloured and satiny; the upper ones lie over the back, covering the under ones in repose (as in fig. 3); there are several short white streaks on the outer edge, except at the base, and a silvery oval ring near the posterior margin, within which are five short black longitudinal lines.

Prevention and Remedies.—The haulm in gardens should be cleared away at once and burnt after the crop is gathered. This is best done on the ground where the peas have grown. In field cultivation, where the haulm cannot be lost, all that can be done is to deeply plough the land so as to bury the pupæ. [J. C.] [F. V. T.]

Grasses.—This is the common name applied to that very important order of monocotyledonous plants called Gramineæ. The object of this article is to explain those peculiarities upon which the agricultural value of grasses depends, and also to indicate those points of construction which must be noticed in order to distinguish one species from another when in leaf, when in ear, and when in seed.

The various details are considered under the following heads:—

I. Distinction between grasses and their allies.
II. Parts of a grass plant.
III. Tillering.
IV. Duration of life.
V. Modes of growth.
VI. Height of grasses when in ear.
VII. Natural habitats of grasses.
VIII. Soils for grasses and indicator grasses.
IX. Grass leaves.
X. How to know grasses by their leaves.
XI. Grass ears.
XII. How to know grasses by their ears.
XIII. Grass seeds.
XIV. How to know grasses by their seeds.
XV. Impurities and adulterants of commercial seed.

I. Distinction between Grasses and their Allies (figs. 1, 2, and 3)

The name 'grass' is often applied to plants which are not at all grasses. For example, clovers, sainfoin, and the like are often spoken of as 'artificial grasses'. These plants are utterly unlike grasses in their construction, and should be called—what they really are—leguminous plants. Again, sedges (Cyperaceæ) and rushes (Juncaceæ) are often confounded with grasses because of a superficial leaf resemblance and flower resemblance. Attention to the following points of distinction will prevent such confusion. Grass leaves are always arranged in two rows, never in three or more; the blade of the leaf is flat, rarely cylindrical, and never triangular; the leaf-sheath is split down one side (fig. 2) and not entire. Exceptions occur in *hard*

fescues, where the blade is folded together so as to resemble a cylindrical bristle; and in Wavy Hair Grass (*Aira flexuosa*) the leaf blade actually is a solid bristle. In Cocksfoot, again, the leaf-sheath is entire, and the same is the case with Brome grasses. The grass stem takes the form of a hollow cylindrical straw, and is neither solid, nor filled with pith, nor triangular. Only

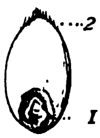


Fig. 1

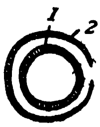


Fig. 2

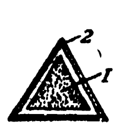


Fig. 3

Fig. 1.—Diagram of Wheat Grain, viewed from the back. 1, Basal end with embryo shining through the skin. 2, Apical end.
Fig. 2.—Diagram of Grass, showing (1) the hollow stem surrounded by (2) the split leaf-sheath.
Fig. 3.—Diagram of Sedge, showing the solid triangular stem (1) within the entire triangular leaf-sheath (2).

in tropical grasses, such as Sugar Cane, and in certain cereals, such as Indian Corn, is the straw solid. The grain of a grass has a very characteristic structure: it is filled with a starchy substance (endosperm tissue), and shining through the skin of the grain the embryo is easily seen at one end (the basal end). It is now easy to specify the distinctions between grasses and sedges on the one hand, and between grasses and rushes on the other:—

Grasses.	*Sedges.*
Leaves in two rows.	Leaves in three rows.
Split leaf-sheath.	Entire leaf-sheath.
Stem cylindrical and hollow.	Stem usually triangular and always solid.
The grain shows the embryo at one end.	Grain does not show the embryo.

Grasses.	*Rushes.*
Leaf-blade flat usually.	Leaf-blade cylindrical; flat in Woodrush (Luzula).
Stem hollow.	Stem solid.
Flowers concealed within a husk of pales; three stamens per flower.	Flowers exposed; six stamens per flower.
Fruit a one-seeded grain.	Fruit contains several seeds.

II. Parts of a Grass Plant

The body of a grass plant (fig. 4) is composed of fine fibrous roots for absorbing the minerals plus water from the earth, and of shoots for manufacturing organic foodstuffs from inorganic materials. Each shoot bears its own bunch of fibrous roots at the base, and young shoots (buds) in the axils of the lower leaves. The shoot starts as a bud, develops into a leafy shoot, and dies after it has produced its straw and ripened its ear.

III. Tillering

Tillering is the process by which one shoot gives out many. When a grain of wheat is sown, for example, the bud or plumule of the embryo emerges from the grain as a first shoot, enclosed in a sheathing cotyledon. But at the base of this shoot, buds are produced, and from these buds new and extra shoots are developed later on. These extra shoots are the tillers. This tillering or stooling-out process is the same as that by which a tree increases the number of its branches, only, in the case of the grass the branch-shoots or tillers are produced at or under the ground, instead of higher up in the air as is the case for a tree. The thickening of a sole of grass and its yield of produce evidently depend upon the production of an in-

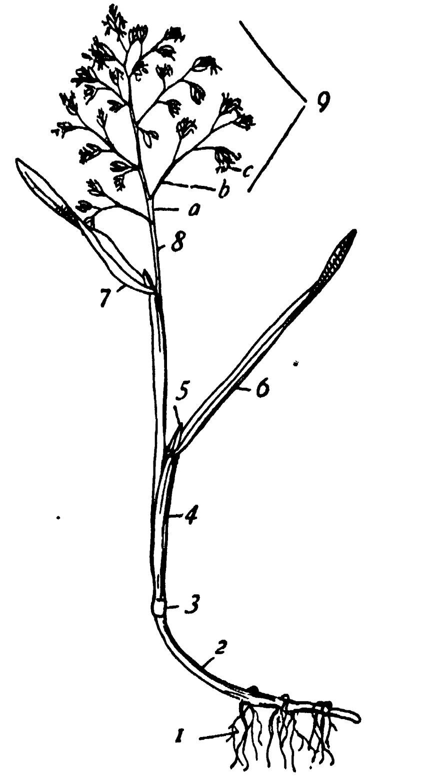


Fig. 4.—Diagram showing parts of a Grass

1, The root fibres.
2, Underground base of shoot.
3, Knot, 4, Sheath, 5, Ligule, 6, Blade — Parts of Leaf.
7, Uppermost leaf on straw
8, Part of straw below ear (stalk).
9, Ear.
a, Axis of ear. *b*, Branch of axis of ear. *c*, Spikelet.

creased number of shoots by the tillering process. Accordingly, for making a good meadow or pasture, those species are selected and called good which are gifted with high tillering power, and which animals readily eat. Cereal as well as meadow and pasture grasses have tillering power, and the extent to which this power is exercised depends upon the species, and much upon the circumstances of the case. For example, the variety of oat called Tam Finlay naturally excels in tillering power, and yields a high proportion of straw, whereas other oat varieties, such as Tartar King, tiller very little, and yield a higher proportion of grain. The

extent to which tillering occurs in a meadow or pasture depends much, as we have said, upon the environment and the mode of management. Rolling in spring, for example, favours tillering, so does judicious depasturing, and cutting the hay before the seed is ripe. If the shoots are eaten down too early, or if the seed is allowed to ripen, the grass plant may become so exhausted that it has not the wherewithal to make the tillers and develop them into new shoots: as a result, the plant ceases to tiller, and soon dies out. By injudicious management, the useful plants of a pasture may be more or less ousted, and the useless weeds, less interfered with by the browsing stock, get the upper hand.

IV. Duration of Life

Certain species of grasses exhaust their powers of tillering and producing new shoots within a single season. Annual Meadow Grass, for example, develops all its buds into branch shoots, which exhaust themselves in seed production within a year; no buds are left over to continue the growth, and this is accordingly an *Annual Grass*. A special use for an annual variety of Rye Grass is in connection with the formation of a Timothy meadow. For this purpose, Italian Rye Grass is often used along with the Timothy, but the Annual Rye Grass has at times an advantage, for since its leaves are smaller, and its growth less luxuriant, there is less danger of checking the growth of the young Timothy plants. Other short-lived grasses are Italian and Perennial Rye grasses, as well as many species of Brome grasses. Within a season, the bulk of the shoots of Italian are exhausted, and by the end of the second year most of the plants have died out. Perennial Rye Grass often lives only for three years, but on heavy lands, which specially suit this species, it may continue growing for six years or longer. In the ordinary practice of farming, however, it is found unsafe to rely upon the productive powers of Rye Grass for more than three years. This should be borne in mind, when laying down land to pasture; if permanence is a main object, the amount of Rye Grass should certainly be restricted within narrow limits. Cocksfoot, Timothy, Meadow Fescue, and Meadow Foxtail are true perennials, which continue to tiller and produce new shoots for many years in succession: such are called perennial or permanent grasses.

To determine whether a grass is a perennial or not, the shoots must be carefully examined. If all the shoots of the current year are in ear, or if, when teased out, each shoot is found to contain a young ear, the grass is certainly not a perennial but an annual or a biennial. If, however, the grass bears stumps of old shoots, or if there are remains of old leaves, or if there is an underground creeping stem (fig. 5), or if barren shoots composed entirely of leaves and containing no ear are present, then the grass is certainly a perennial. There is no sharp line between annual and biennial grasses, for the duration of these shortlived species, whether for one or for two years, often depends upon special circumstances.

TABLE I.—DURATION OF GRASSES (cultivated species are printed in **thick type**)

ANNUALS—

Cereals.

Spike Ear—

Annual Rye Grass.
Darnel Rye Grass.
Wall Barley.
Cultivated Canary Grass.

Panicle Ear—

Annual Meadow Grass.
Early Hair Grass.
Silvery Hair Grass.
Soft Brome.
'Hair Grass' (*Festuca Myurus*).

BIENNIALS—

Spike Ear—

Italian Rye Grass.
Slender Foxtail.
Water Foxtail.

Panicle Ear—

Rough Brome.
Barren Brome.

TRIENNIAL—

Perennial Rye Grass (often).

PERENNIALS—

Spike Ear—

Moor Mat Grass.
Crested Dog's-tail.
Couch grasses.
Sea Lyme Grass, Sea Mat Grass } Sand binders.
Timothy.
Wood Barley.
False Brome grasses.

Panicle Ear—

Yorkshire Fog, Creeping Soft Grass, Sweet Vernal, **Golden Oat**, **Upright Brome** } Hairy.
Awnless Brome.
Common Bent.
Fiorin.
Tall Oat (non-bulbous variety).
Tall Oat (bulbous), usually hairy.
Meadow Oat Grass.
Downy Oat Grass (hairy).
Tufted Hair Grass.
Cocksfoot.
Tall Fescue.
Meadow Fescue.
Smooth-stalked Meadow Grass.
Rough-stalked Meadow Grass.
Wood Meadow Grass.
Quaking Grass.
Hard Fescue, **Sheep's Fescue**, **Creeping Fescue**, **Various-leaved Fescue**, Sea Meadow Grass } Bristle-leaved.
Common Reed, Reed Canary Grass, **Floating Sweet Grass**, Water Meadow Grass } Water reed grasses.

V. Modes of Growth

In certain grasses, such as Cocksfoot and Timothy, the tiller shoots grow vertically up into the air, and thus there is produced a tuft of shoots standing close together. These are the *Tufted Grasses*. In other cases, such as Couch Grass, the *creeping* habit of growth prevails

(fig. 5); the tiller shoots run for a distance horizontally beneath the ground, producing roots as they go, and then bend up to reach the light with their green leaves. When this creeping habit of growth is strongly pronounced, we have the makings of a weed specially dangerous on light land, where extension in the horizontal direction is easy and rapid. In such cases, there is an extensive underground establishment to be kept up, into which is packed away most of the valuable foodstuffs produced by the green herbage of the plant, and consequently inaccessible to the browsing stock. Besides, a mere fragment of the underground shoot left in the ground suffices to propagate anew, and so, expensive cleaning operations are necessary, if we would

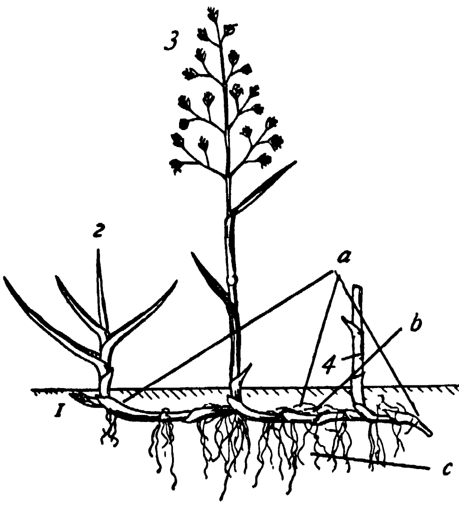


Fig. 5.—Diagram showing mode of growth of an Underground Creeping Grass

1, Shoot in bud form (current year). 2, Barren shoot (was in bud form last year). 3, Fertile shoot (was a barren shoot two years ago). 4, Old stump (was a fertile shoot three years ago). *a*, Underground stem for storage and propagation. *b*, Its scale leaves. *c*, Its root fibres.

prevent such weeds from overrunning the land, interfering with our crops, and diminishing the produce. The weak point of such underground creepers as Couch Grass is this: the dangerous part is underground, and so deep that we can prevent the nitrates which are formed in the surface soil from reaching the absorbing roots of the weed. This mode of checking the growth of Couch is brought into action by laying land which is foul with Couch under grass for three or four years. The more tufted grasses growing along with the creeping Couch absorb the nitrates so completely, that the roots of the Couch, occupying a deeper layer of the soil, are stinted of nitrate supply, and so the weed must soon die out from sheer starvation.

Another case of creeping growth is met with in Common Bent Grass (*Agrostis vulgaris*), and to a more limited extent in Rough-stalked Meadow Grass (*Poa trivialis*). Here certain tiller shoots run along the surface of the ground, strike root, and then bend up vertically into the air. Evidently surface creepers such as these thrive best on land with surface moisture, and if the surface should become dry, growth would be checked. But it is not so with Common Bent, which is equally at home whether the moisture is on the surface or in the depths of the soil. In fact, Common Bent adapts its mode of growth to those circumstances in which it finds itself—if the water is on the surface, it is a surface creeper, and if the water is deep underground, it becomes a deep underground creeper. In Common Bent, therefore, we have a formidable weed, for it is not readily eaten, it can propagate from a mere fragment of the shoot, and it can adapt itself to all classes of land. Although we cannot starve out Bent Grass by putting it into competition with other grasses for supplies of nitrate, still there is a weak point—the leaves are small; that is to say, Bent is a sole or bottom grass (see leaf of natural size, fig. 17). We take advantage of this peculiarity by laying down the land affected by Bent under large-leaved top grasses, such as Cocksfoot, Timothy, Tall Fescue, French Rye Grass, &c. The competition is now for light, and the large-bladed grasses shade the Bent more or less completely, so as to diminish its powers of renewing food supplies and so of forming new shoots. Cases are known in which this procedure has, at least, kept the Bent Grass in check.

A peculiar mode of growth is found in connection with the troublesome bulbous variety of False Oat (*Arrhenatherum avenaceum* var. *bulbosum*), and this peculiarity is so striking that it has given rise to the common name Pearl Grass. The shoots in this case form a loose tuft, but the underground base of each shoot of the tuft forms a row of pearl-like swellings, erroneously called *bulbs*. Each swelling is a store of nutriment, easily detached, and ready to propagate the plant anew. The leafy air part of the shoot, drained of food to supply the underground 'pearls', is poor in nutriment, and remains uneaten by the browsing stock, so that the underground parts are allowed to add to their stock of 'pearls' and to store away their nutriment unchecked. Thus, Pearl Grass is one of the most troublesome pests of light land. If we could do away with the pearls, and retain the nutriment in the leaves, we would have at our command a most valuable grass for light land. Such a variety is well known, and occurs in commerce as French Rye Grass, or non-bulbous False Oat Grass (*Arrhenatherum avenaceum* var. *non-bulbosum* or *Avena elatior* var. *non-bulbosum*). Mixed modes of growth are characteristic of several pasture grasses. Meadow Foxtail, for example, forms a loose tuft of shoots which creep for a short distance underground. Perennial Rye Grass, though tufted in the main, has a touch of the creeping habit, for some of its shoots also creep a short distance underground; and Rough-stalked Meadow Grass combines surface creeping with the tufted mode of growth. It is clear that grasses which form close tufts cannot by themselves form a completely closed sward—intervals must occur between the tufts; but if the tufts are loose, or if the tufted and creeping habits are combined, the various shoots can cross, and by interming-

ling and interlacing form a complete sward of grass.

We are now ready to tabulate the modes of growth under five heads: (1) tufted; (2) creeping underground; (3) creeping above-ground; (4) creeping under or above ground; and (5) with tuberous swellings at the base of the shoot (bulbous growth).

TABLE II.—MODES OF GROWTH (cultivated grasses are printed in **thick type**)

1. TUFTED GRASSES—

With Bristle Leaves—

Sheep's Fescue.
Hard Fescue.
Moor Mat Grass.
Wavy Hair Grass.
'Hair Grass' (*Festuca Myurus*).
Early Hair Grass.
Silvery Hair Grass.

With Flat Leaves—

Cereals—Annual.	Top grasses.
Tall Oat (non-bulbous variety)	
Cocksfoot	
Brome grasses (except Awnless Brome)	
Wood Couch	
Wood Barley	
Crested Dog's-tail	Bottom grasses.
Wood Meadow Grass	
Annual Meadow Grass	
Tufted Hair Grass	
Purple Molinia	
Decumbent Heath Grass	
Crested Kœleria	

2. UNDERGROUND CREEPERS—

With Bristle Leaves—

Creeping or Red Fescue.
Sea Meadow Grass.

With Flat Leaves—

Smooth-stalked Meadow Grass.		
Sea Mat Grass	Sand binders.	
Sea Lyme Grass		
Floating Sweet Grass	Aquatics.	
Reed Canary Grass		
Common Reed		
Couch Grass.		Top grasses.
Creeping Soft Grass.		
Awnless Brome.		
Meadow Foxtail	loose tufts, *i.e.* creeping only slightly.	
Tall Fescue		
Golden Oat		
Sweet Vernal		

3. CREEPING ABOVE-GROUND (*i.e.* with runners)—

Bottom Grasses with Small Narrow Leaves—

Rough-stalked Meadow Grass (also produces tufts).
Water Whorl Grass—Aquatic.

Top Grass with Large Broad Leaves—

Yorkshire Fog (the runners are often stout and placed vertically, hence this grass is specially difficult to cut with a scythe from the superposition of tuft upon tuft).

4. CREEPING SOMETIMES UNDERGROUND, SOMETIMES ABOVE-GROUND—

Piorin	Bottom grasses.
Common Bent	

5. BULBOUS GRASSES (the base of the stem specially thickened)—

Timothy (the bulbous habit more pronounced on light land; the bulb single at the base of each shoot)	Top grasses.
Tall Oat or Pearl Grass (the bulbs in chains, each bulb representing one internode)	

VI. Height of Grasses when in Ear

In the Tropics, gigantic grasses with woody stems occur; such are the Bamboos. But our native grasses are all herbs with their stems in the form of hollow straws (culms), and when in ear, of diminutive stature as compared with the giants of the Tropics. The tallest are the Water Reed grasses, reaching 6 ft., whereas some species growing on dry sands rise only a few inches above the ground. If our native and cultivated grasses are measured when in full ear, they may for convenience be arranged roughly in three groups: (1) Tall grasses, over 3 ft. high; (2) medium grasses, from 1 to 3 ft., and (3) low grasses, under 1 ft.

TABLE III.—HEIGHT OF GRASSES (those cultivated printed in **thick type**)

1. TALL GRASSES, over 3 ft. high—

Water Reeds—

Common Reed	With panicle ear.
Reed Canary Grass	
Water Sweet Grass	

Cereals—

Rye	With spike ear.
Wheat	
Barley	
Oats—With panicle ear.	

A Sand-binding Grass—

Sea Lyme Grass—Ear cylindrical.

Meadow and Pasture Grasses—

Tall Fescue	With panicle ear.
Tall Oat (non-bulbous variety)	

Weeds—

Tall Oat (bulbous variety)	With panicle ear.
Rough Brome	
Tufted Hair Grass	

2. MEDIUM GRASSES, between 1 and 3 ft. high—

Meadow and Pasture Grasses—

Italian Rye Grass	With spike ear.
Cultivated Canary Grass	
Timothy	
Meadow Foxtail	
Crested Dog's-tail	
Meadow Fescue	With panicle ear.
Cocksfoot	
Golden Oat	
Various-leaved Fescue	
Rough-stalked Meadow Grass	
Smooth-stalked Meadow Grass	
Wood Meadow Grass	

A Sand-binding Grass—

Sea Mat Grass.

Weed Grasses—

Couch Grass	With spike ear
Meadow Barley	
Slender Foxtail	
Wood False Brome	
Heath False Brome	
Sweet Vernal—With spikelike panicle ear.	
Purple Molinia	With panicle ear.
Yorkshire Fog	

3. LOW GRASSES, under 1 ft. high—

Cultivated for Pasture—

Hard Fescue	Bristle-leaved, with panicle ear.
Sheep's Fescue	

Weeds—

Darnel Rye Grass
Moor Mat Grass
} With spike ear.

Soft Brome
Quaking Grass
Decumbent Heath Grass
Annual Meadow Grass
Wavy Hair Grass
Silvery Hair Grass
Early Hair Grass
'Hair Grass' (*Festuca Myurus*)
} With panicle ear.

VII. Natural Habitats of Grasses

Grasses grow in all sorts of situations, and it is of importance to know as accurately as possible the habitat affected by each species, if we would render identification of the grasses easy, and use such indications as a guide to the species most suitable for growing on our own land. The following habitats are here distinguished: (1) Sea-side grasses, on the sand; (2) moor and heath grasses, on downs and dry hills; (3) meadow and pasture grasses; (4) shade grasses, in wood and copse; (5) aquatic and sub-aquatic grasses, in ponds, marshes, ditches, and by riversides; (6) vagabond grasses, on waste ground everywhere.

Table IV.—Habitats of Grasses (cultivated species are printed in **thick type**)

1. Grasses on Sand by the Sea—

Bristle-bladed Grasses—

Sea Meadow Grass
Creeping Fescue
} Panicle ear.

Top Grasses—

Sea Couch
Sea Mat Grass
Sea Lyme Grass
} Spike ear.

2. Moor and Heath Grasses—

Bristle-bladed Grasses—

Moor Mat Grass—Spike ear (a one-rowed spike).

Wavy Hair Grass
Hard Fescue
Sheep's Fescue
} Panicle ear.

Bottom Grasses with Flat and Narrow Blades—

Purple Molinia
Decumbent Heath Grass
Crested Kœleria
Brown Bent
} Panicle ear.

3. Meadow and Pasture Grasses—

Cultivated Top Grasses—

Italian Rye Grass
Meadow Foxtail
Timothy
} Spike ear.

Cocksfoot
Tall Fescue
Meadow Fescue
French Rye Grass or Tall Oat (non-bulbous variety)
} Panicle ear.

Weed Top Grasses—

Meadow Barley—Spike ear.

Soft and Field Bromes
Yorkshire Fog
Creeping Soft Grass
} Panicle ear.

Sweet Vernal—Spikelike panicle ear.

Cultivated Bottom Grasses with Flat Blades—

Perennial Rye Grass
Crested Dog's-tail
} Spike ear.

Rough-stalked Meadow Grass
Smooth-stalked Meadow Grass
Florin
} Panicle ear.

Weed Bottom Grasses with Flat Blades—

Quaking Grass
Perennial Oat Grass
Downy Oat Grass
Common Bent
} Panicle ear.

Cultivated Bristle-bladed Grasses—

Sheep's Fescue
Hard Fescue
} Panicle ear.

4. Shade Grasses—

Top Grasses with Broad Blades—

Wood Couch
Wood Barley
Wood False Brome
} Spike ear.

Tall Oat (non-bulbous)
Tall Oat (bulbous)
Cocksfoot
Tufted Hair Grass
Wood Melic
Wood Millet
} Panicle ear.

Bottom Grass with Narrow Blades—

Wood Meadow Grass—Panicle ear.

5. Aquatic and Sub-aquatic Grasses—

Tall Reeds with Broad Leaves—

Common Reed
Reed Meadow Grass
Reed Canary Grass
} Panicle ear.

Floating Sweet Grass—Raceme ear.

Bottom Grasses with Narrow Leaves—

Water Foxtail—Spike ear.

Florin
Decumbent Heath Grass
Water Whorl Grass
} Panicle ear.

6. Vagabond Grasses, on Waste Land—

Top Grasses with Broad Blades—

Couch Grass
Wall Barley
Slender Foxtail
} Spike ear.

Soft Brome
Barren Brome
Yorkshire Fog
Creeping Soft Grass
} Panicle ear.

Bottom Grasses with Narrow Flat Blades—

Perennial Rye Grass
Purple Molinia
Annual Airas
Annual Meadow Grass
} Spike ear.

Bristle-leaved Grasses—

Sheep's Fescue
Hair Fescue Grass
} Panicle ear.

VIII. Soils for Grasses and Indicator Grasses

The soils distinguished here are: (1) Very dry sands; (2) moist sands; (3) poor, dry loams; (4) good loams and alluvial soils; (5) moist or irrigated good soils and clays. For marsh and bog grasses see Marsh and Bog Plants.

Table V.—Soils for Grasses (cultivated species in **thick type**)

1. Grasses Natural to Very Dry Sand—

Top Grasses—

Couch Grass—Spike ear.

Creeping Soft Grass—Panicle ear.

Bottom Grasses with Flat Blades—

Smooth-stalked Meadow Grass
Wood Meadow Grass
Common Bent
Brown Bent
Crested Kœleria

Bristle-bladed Grasses—

Creeping Fescue
Sheep's Fescue
Hard Fescue
Wavy Hair Grass
} Panicle ear.

Sand-binding Grass—

Sea Mat—Cylindrical ear.

2. Grasses Natural to Moist Sands—

Moor Mat Grass—Spike ear.
Fiorin—Panicle ear.

3. Grasses Natural to Poor, Dry Loams—

Top Grasses—

Couch Grass—Spike ear.

Tall Oat (non-bulbous variety)	Panicle ear.
Tall Oat (bulbous variety)	
Cocksfoot	
Yorkshire Fog	
Sweet Vernal	
Soft Brome	

Bottom Grasses—

Crested Dog's-tail—Spike ear.

Smooth-stalked Meadow Grass	Panicle ear.
Glabrous Oat Grass	
Downy Oat Grass	
Common Bent	
Decumbent Heath Bent	

Bristle-bladed Grasses—

Sheep's Fescue	Panicle ear.
Hard Fescue	
Creeping Fescue	
Various-leaved Fescue	

4. Grasses Natural to Good Loams and Alluvial Soils—

All the cultivated grasses occur here.

5. Grasses Natural to Good Soils, Moist or Irrigated, and to Clays—

Top Grasses—

Italian Rye Grass	Spike ear.
Meadow Barley	
Meadow Foxtail	
Timothy	
Cocksfoot	Panicle ear.
Tall Oat (non-bulbous variety)	
Tall Fescue	
Smooth Brome	

Bottom Grasses—

Crested Dog's-tail—Spike ear.

Golden Oat Grass	Panicle ear.
Rough-stalked Meadow Grass	
Fiorin	
Quaking Grass	
Bristle-leaved—	
Creeping Fescue.	

Certain grasses are of interest because they indicate special soil peculiarities. These are called Indicator grasses.

Table VI.—Indicator Grasses

1. *Sand Indicators*—

Bristle-leaved grasses.
Barren Brome.
Awnless Brome.

2. *Clay Indicator* –

Smooth Brome (*Bromus arvensis*).

3. *Common Salt Indicators*—

Sea Couch Grass	On dry sand.
Sea Mat Grass	
Sea Lyme Grass	On wet sand.

4. *Potash Indicators*—

Purple Molinia	In damp soils and in water.
Floating Sweet Grass	
Reed Canary Grass	
Perennial Rye Grass	In drier soils.
Meadow Foxtail	
Yorkshire Fog	
Quaking Grass	

5. *Chalk and Limestone Indicators*—

Quaking Grass.
Crested Kœleria.
Perennial Oat Grass.

6. *Indicators of 'Sour' Land*—

Water Foxtail.
Moor Mat Grass.
Tufted Hair Grass.
Purple Molinia.
(Also Sedges and Rushes.)

7. *Indicators of Presence of much Humus* (*Shade Grasses*)—

Wood Melic.
Wood False Brome.
Rough Brome.

IX. Grass Leaves

On a grass plant it is useful to distinguish two sets of leaves: (1) the *ground leaves*, which form the herbage of the pasture, and (2) the *straw leaves*, borne by the straw, often called cauline leaves. When distinguishing grasses in their leafy state, it is, of course, not the straw-borne leaves but the ground leaves of the pasture that are referred to. The important point is that these ground leaves are often constructed differently from the straw leaves, and confusion of these two kinds may easily lead to error. For example, one reads that Rough-stalked Meadow Grass has a long acute ligule on its leaf; but this refers to the leaves on the straw, and more particularly to the uppermost leaf immediately below the ear (fig. 6).

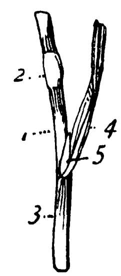


Fig. 6.—Smooth-stalked Meadow Grass—Straw-borne Leaf (natural size).

1, Straw.
2, Long light-coloured knot
3, Sheath
4, Blade
5, Long acute ligule

(2–5: Leaf.)

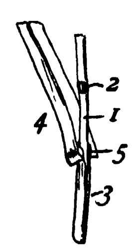


Fig. 7.—Wood Meadow Grass—Straw-borne Leaf (natural size).

1, Straw.
2, Short black knot
3, Sheath
4, Blade
5, Short ligule

(2–5: Leaf.)

The Leaf as a Whole.—Three parts are readily distinguished on the ground leaf: (1) sheath, (2) blade, (3) ligule.

The leaf on a straw shows four parts—(1) the *knot* of the sheath, (2) the remainder of the sheath, (3) the blade, and (4) the ligule (fig. 4). The knot may be long and straight (fig. 6), or long and bent (as in Water Foxtail), or quite short (fig. 7), sometimes bald, sometimes hairy, sometimes with a downward sloping ring of hairs (as in creeping soft grass), and so forth.

The Sheath.—When examining the sheath of a ground leaf, the points to notice are—(1) whether split or not, (2) whether netted or not, (3) the shape of its section, (4) its colour, and (5) presence or absence of hair. The sheath

is usually split open (fig. 2), but at times it is partially or completely closed. The grasses with a closed (unsplit) sheath are:—

MEADOW AND PASTURE GRASSES—

Cultivated—

Cocksfoot—Top grass.
Rough-stalked Meadow Grass } Bottom
Smooth-stalked Meadow Grass } grasses.

Weeds—

Brome grasses—Top grass (fig. 14).
Quaking Grass—Bottom grass (fig. 8).

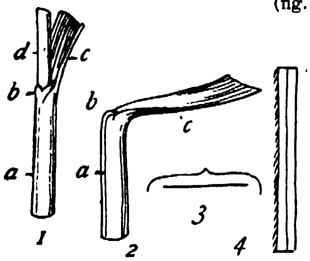


Fig. 8.—Quaking Grass (*Briza media*)

1, Portion of a shoot. 2, Portion of leaf, side view. 3, Ligule magnified and spread out. 4, Magnified margin of blade, with points sloping downwards (and therefore rough upwards). *a*, Closed sheath. *b*, The short ligule. *c*, Base of blade. *d*, Young leaf rolled and erect.

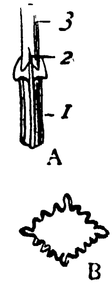


Fig. 9.—Wood Melic Grass

A, Natural size. 1, Entire sheath. 2, Characteristic awl-shaped process at its apex. 3, Straw. B, Magnified section across the quadrangular closed sheath.

Wood Grasses—

Wood Melic (fig. 9).
Nodding Melic.

Water Grasses—

Water Meadow Grass.
Water Sweet Grass.

When the sheath of certain aquatic grasses is held up to the light, it appears divided up into quadrangular areas. This netlike appearance is due to air spaces, and is characteristic of the *net-sheathed grasses*, of which there are two kinds:—

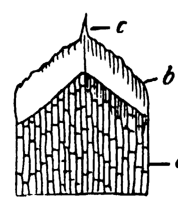


Fig. 10.—Water Meadow Grass with Netted Sheath

a, The sheath split and laid flat. *b*, The ligule. *c*, Its awnlike point.

1. *With Flat Sheaths—*
   Water Meadow Grass.
   Floating Sweet Grass.
   Water Whorl Grass.
2. *With Round Sheaths—*
   Reed Canary Grass.
   Northern Holy Grass.

The shape of the section of the sheath is often characteristic. It is:—

1. *Round*—Italian Rye Grass.
2. *Flat*—Perennial Rye Grass.
3. *Flat and two-edged*—Cocksfoot.
4. *Quadrangular*—Wood Melic (fig. 9).

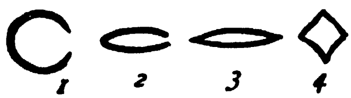


Fig. 11.—Forms of Sheath

1, Round. 2, Flat. 3, Flat and two-edged. 4, Quadrangular.

A characteristic colouring matter is often developed in the base of the sheath:—

Red in Rye grasses, Creeping or Red Fescue, and Meadow Fescue.
Yellow in Dog's-tail.
Violet in Foxtail.
Red veins in a white ground—Characteristic of the hairy grass, Yorkshire Fog.

The Leaf-blade. — This often shows features very characteristic of different grasses. The points to notice are—(1) the form and breadth, (2) the base, (3) the apex, (4) the surface, (5) the texture, and (6) the ptyxis, *i.e.* whether folded or rolled in the bud. First we distinguish flat blades as—

Broad, *e.g.* Cocksfoot.
Narrow, *e.g.* Perennial Rye Grass.

The most expressive terms for agricultural purposes are:—

TOP GRASS, for large broad blades, *e.g.* Cocksfoot.
BOTTOM GRASS, for small narrow blades, *e.g.* Perennial Rye Grass.

In other cases, the leaf-blade is not flat but takes the form of a bristle, and is called BRISTLE-LIKE (setaceous). This bristle form of blade is an adaptation for growth on dry sands, for moor and hill and heath, wherever water is scarce.

Examples of bristle blades are:—

Cultivated Grasses—

Sheep's Fescue.
Hard Fescue.
Creeping Fescue.
Various-leaved Fescue (ground leaves alone bristle-like).

Weed Grasses—

'Hair Grass' (*Festuca Myurus*—Annual).
Wavy Hair Grass.

} Panicle ear.

Three kinds of bristle blades are distinguished:—

1. Solid, in Wavy Hair Grass and Moor Mat Grass.
2. Folded, in Sheep's Fescue.
3. U-shaped (channelled), in Sea Meadow Grass.

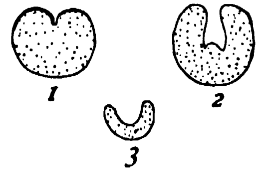


Fig. 12.—Sections of Bristle Blades

1, Solid. 2, Folded. 3, U-shaped.

The base of the leaf-blade often shows features important for distinction. It is specially narrowed (linear lanceolate) in Purple Molinia, False Bromes, Wood Melic, Wood Millet, and Crested Kœleria (see fig. 13).

Again, the base of the leaf-blade where it joins the sheath may have special prolongations called ears (fig. 14): these ears are characteristic of a whole group of grasses. There are three forms: (1) Round ears, *e.g.* Sweet Vernal; (2) straight and pointed ears, *e.g.* Rough

Brome; (3) curved and pointed ears, *e.g.* Couch Grass.

The apex of the leaf-blade is often characteristic: *e.g.* Smooth-stalked Meadow Grass has a blade with parallel margins and the apex

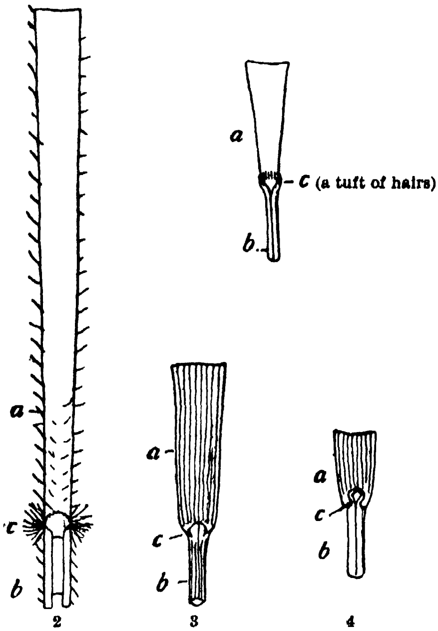


Fig 13 —Showing Narrowed Base of Leaf-blade

1, Purple Molinia 2, Wood False Brome. 3, Wood Melic. 4, Wood Millet.
a, Base of leaf-blade. *b*, Sheath. *c*, Ligule.

rounded off, whereas Rough-stalked Meadow Grass has a blade getting narrower and narrower till it ends in the acute point (fig. 15). In the sand-binding grasses, Sea Lyme and Sea Mat Grass, the apex of the hard blade is rolled up so as to form a spine apex.

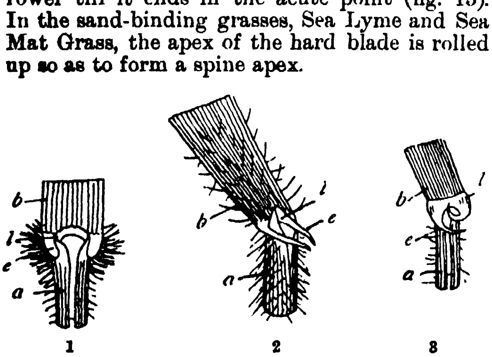


Fig. 14.—Showing Ears at Base of Leaf-blade

1, Sweet Vernal. 2, Rough Brome, with entire sheath. 3, Couch with rudimentary ligule.
a, Sheath. *b*, Base of leaf-blade. *e*, Ear. *l*, Ligule.

The surface of the leaf-blade often shows characters important for purposes of distinction. Tufted Hair Grass (fig. 16), for example, is distinguished from all other grasses by the surface of its blade—it is rough like a file, and the upper surface has seven strong acute ribs. When this blade is held up to the light, seven dark strips represent the thick ribs, and seven white lines the thin parts of the blade between.

The *ribbing* of the upper surface of the leaf-blade often affords useful indications for distinguishing various species of grasses, as shown by fig. 17. There are: (1) no ribs in all Meadow grasses (Poa), Bald Perennial Oat Grass, Downy Oat Grass, and Cocksfoot; (2) low, flat, inconspicuous ribs in Timothy, Tall Oat, Meadow Foxtail, Quaking Grass, and Reflexed Meadow Grass, also in certain hairy grasses, viz. Decumbent Heath Grass, and Couch; (3) prominent rounded ribs on the upper surface, and a very glossy lower surface, as in Rye grasses. Common Bent (*Agrostis vulgaris*) has also the prominent ribs, but there is no gloss on the lower surface, and the ligule is much longer than in a Rye Grass; (4) the ribs are very conspicuous, acute rather than rounded, in Tufted Hair Grass and Water Foxtail, also in the sand binders, viz. Sea Mat Grass, and Sea Lyme Grass.

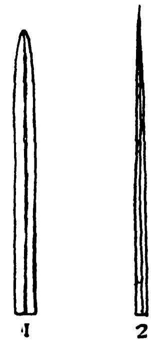


Fig. 15

1, Smooth-stalked Meadow Grass (nat. size). Leaf-blade with rounded apex and parallel edges. 2, Rough-stalked Meadow Grass (nat. size) Leaf-blade with acute apex.

When a leaf-blade is held up to the light, the amount of contrast between the darker rib and the lighter furrow is a rough guide to the height of the ribs. A Water Foxtail leaf-blade, for example, would show much more contrast than a blade of Water Fiorin Grass (*Agrostis stolonifera*)—in the former species the ribs are very high.

The *texture* of the leaf-blade is often important. Cultivated grasses have edible leaves,

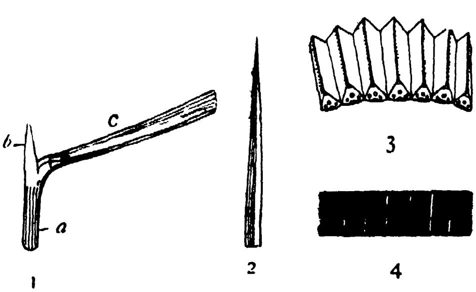


Fig. 16.—Tufted Hair Grass (*Aira cæspitosa*)

1, Portion of Leaf (*a*, sheath; *b*, long acute ligule; *c*, base of blade). 2, Apex of leaf. 3, Magnified portion of leaf-blade, showing the seven rough ribs. 4, The same portion viewed by transmitted light.

and the blades of these are described as of herbaceous texture. In certain cases the blade is hard like leather (coriaceous), as in the Sand grasses, viz. Sea Lyme, Sea Mat, and Sea Couch, also in Heath False Brome, and in the Moor Mat Grass with bristle blades. Thin and dry blades are characteristic of Couch Grass, Wood False Brome, Meadow Barley, and Perennial Oat.

Folded and Rolled Leaves (fig. 18).—When

one observes the young leaves emerging from the shoot of Cocksfoot Grass, it is easy to notice that they are opening out of a fold, and when the whole shoot is pulled up it is seen to be flat. These facts are shortly expressed by saying that the leaves are folded (conduplicate ptyxis). Again, notice young Italian leaves; they are

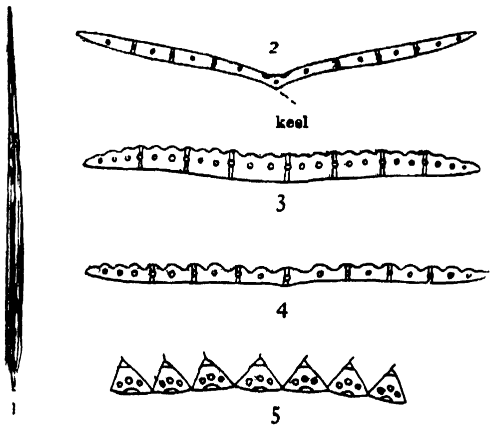


Fig. 17.—Showing Ribs on Upper Surface of Leaf-blade

1, Common Bent (*Agrostis vulgaris*), showing size and form of blade. 2, Magnified section of blade of smooth stalked Meadow Grass. 3, Magnified section of Timothy blade. 4, Magnified section of blade of Common Bent. 5, Magnified section of blade of Tufted Hair Grass

seen to be unrolling and not unfolding, and when the shoot is pulled up it is seen to be stout and round. In the case of Italian, we say that the leaves are rolled (convolute ptyxis). The only cultivated grasses whose leaves unfold (not unroll) are:—

Top Grasses—
Cocksfoot.
Upright Perennial Brome.

Bottom Grasses—
Perennial Rye Grass.
Crested Dog's-tail.
All Meadow grasses (Poa).

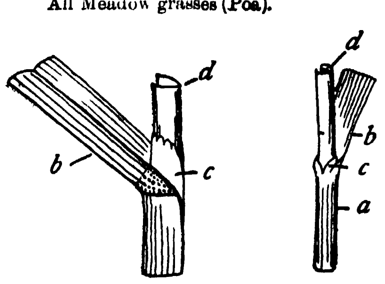
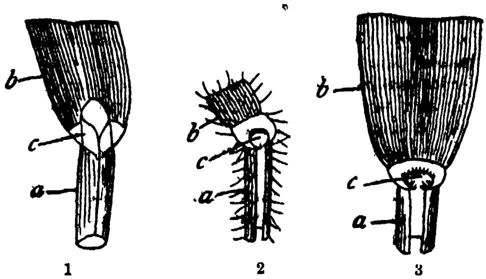


Fig 18.—Showing Folded and Rolled Leaves

1, Cocksfoot, young leaf unfolding. 2, Quaking Grass, young leaf unrolling
a, Entire sheath. *b*, Base of blade. *c*, Ligule. *d*, Section of young leaf-blade.

The Ligule.—This is a special outgrowth at the junction between the sheath and blade of the leaf (figs. 4 and 19). Usually it is a thin membrane, but sometimes, as in Moor Mat Grass, it is quite thick. The ligule is long and acute in Tufted Hair Grass (fig. 16, 1*b*), long and blunt in Reed Canary Grass, but reduced to a mere margin



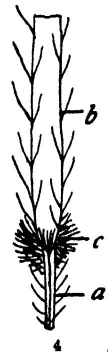


Fig 19.—Showing Forms of Ligule

1, Reed Canary Grass (ligule a membrane). 2, Couch (ligule rudimentary). 3, Common Reed (ligule a hair tuft) 4, Decumbent Heath Grass (ligule a hair tuft)
a, Sheath. *b*, Base of blade *c*, Ligule.

in Meadow Fescue, Tall Fescue, Sheep's Fescue, Hard Fescue, Couch Grass, and Crested Kœleria. Three grasses have the ligule represented by a tuft of hair, Purple Molinia, Decumbent Heath Grass, and Common Reed Grass, and by this feature these are easily distinguished from all other grasses.

X. How to know Grasses by their Leaves

This is the problem presented to anyone who wishes to know the names of the grasses eaten down in a pasture. The material at command is not the ear, but the shoots with their leaves. The secret for success in identifying grasses by their leaves consists in paying close attention to the characters distinctive of the commonest species, so that these can be immediately recognized. It is advisable to begin with a young pasture laid out with Rye grasses. Pull up some of the shoots, and look first at the basal part that was underground. Select for examination those shoots that appear strikingly red. Some of these shoots are quite flat, the leaf-blades are folded along the middle line, and very glossy on the lower surface. This is *Perennial Rye Grass.* Other red-based shoots are not flat but stout and round, with the leaf-blades rolled up, also very glossy on the lower surface. Such shoots are those of *Italian Rye Grass.* Notice specially that Perennial Rye Grass is a *bottom grass* with narrow blades, and Italian a *top grass* with broad blades. Examine next an older pasture, laid down with Timothy, Cocksfoot, and other grasses. Pull up shoots evidently belonging to large top grasses. Some of these shoots will be quite flat and sharp at the edges, with the blades folded up and ribless on the upper surface. Such shoots are those of *Cocksfoot*—no other pasture grass has flat shoots and large leaf-blades. Other shoots will be round and stout, with a specially thickened base (bulbous),

and the leaves rolled round one another. These are the shoots of *Timothy*. Look next among the uneaten top grass for hairy tufts. Pull up some of these hairy shoots. If they are round and plump, and have a white sheath with red veins, the grass is certainly the pestilent *Yorkshire Fog*. Three other common pasture grasses should be carefully examined, viz.: *Smooth-stalked Meadow Grass*, a bottom grass with flat shoots and ribless blade; the ubiquitous *Common Bent*, another bottom grass, with the creeping habit of growth, round shoots, a ribbed blade of a characteristic shape (see fig. 17), and a well-marked ligule; and thirdly, *Hard Fescue*, with tufted growth and bristle-like leaf-blades.

For purposes of distinction by their leaves, grasses may be arranged in nine groups:—

Group 1.—Aquatic reed grasses.
Group 2.—Bristle-bladed grasses.
Group 3.—Sand binders, with large hard blades.
Group 4.—Bulbous grasses.
Group 5.—Meadow and pasture grasses, with flat shoots and no hair.
Group 6.—Meadow and pasture grasses, with the underground base of the shoot characteristically coloured.
Group 7.—Hairy grasses, with flat shoots.
Group 8.—Bald meadow and pasture grasses, with round shoots.
Group 9.—Hairy grasses, with round shoots.

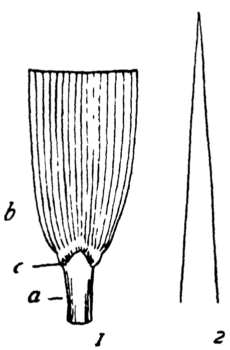
GROUP 1.—WATER REED GRASSES

Round Shoots and Leaves Rolled in Bud.

Ligule a Tuft of Hair.

Common Reed Grass (*Phragmites communis*).

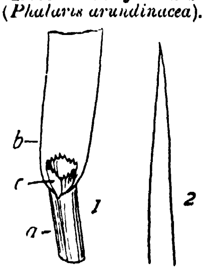
Shoots as thick as the finger.

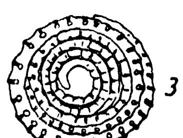


1. Portion of Leaf.
   a, Sheath; *b*, base of blade; *c*, ligule a hair tuft.
2. Acute Apex of Blade.

Ligule a prominent Membrane.

Reed Canary Grass (*Phalaris arundinacea*).





1. Portion of Leaf.
   a, Sheath; *b*, base of blade; *c*, long ligule.
2. Acute Apex of Blade.
3. Magnified Section of the Rolled Leaf-blade.

Flat Shoots and Leaf-blades Folded in Bud.

Water Meadow Grass (*Poa aquatica*).

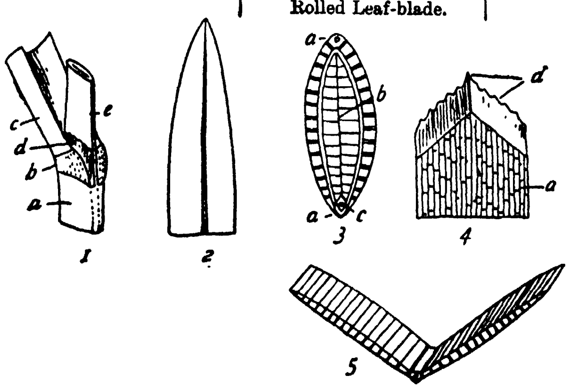
(See diagram below.)

1. Portion of a Shoot.
   a, The sheath; *b*, the brown triangle at base of blade; *c*, base of old blade; *d*, the ligule; *e*, folded young blade.
2. Apex of Blade.
3. Magnified Section of Young Shoot.
   a, Acute edge of sheath; *b*, folded leaf-blade; *c*, its midrib.
4. Magnified View of Sheath and Ligule spread out.
   a, The netted sheath; *d*, the ligule, with a point.
5. Magnified Section of the Ribless Blade.

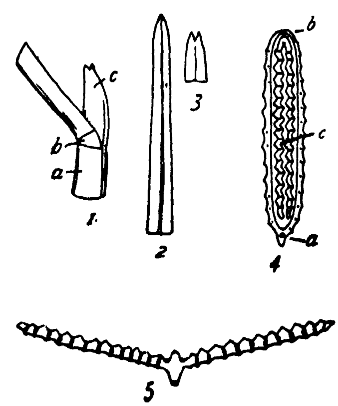
Floating Sweet Grass (*Glyceria fluitans*).

(See diagram below.)

1. Portion of Leaf.
   a, Sheath; *b*, the yellow triangle at base of blade; *c*, the long ligule.
2. Apex of Blade.
3. Hooded Apex split open.
4. Section of Young Shoot.
   a, *Keel* of sheath; *b*, *rounded* margin of sheath; *c*, folded leaf-blade within the sheath.
5. Magnified Section of the Ribbed Blade.

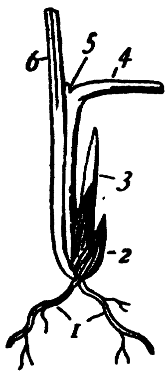
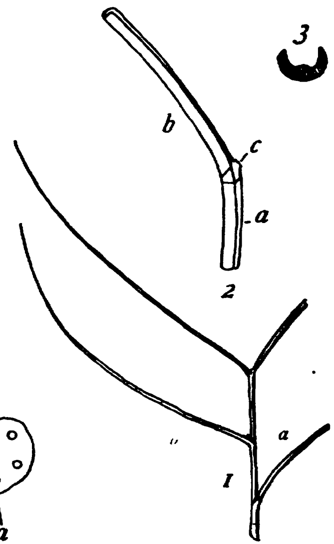
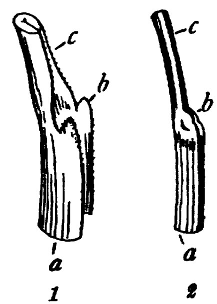


Water Meadow Grass (*Poa aquatica*).
See description above.



Floating Sweet Grass (*Glyceria fluitans*).
See description above.

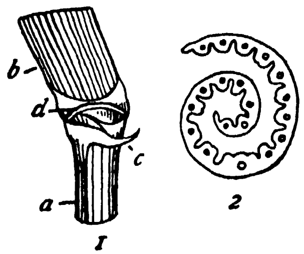
GROUP 2.—BRISTLE-BLADED GRASSES

Bristle Stout and Hard; when old, spread out and horizontal. Ligule thick and short.	Bristle Solid, Erect, and Fine. Ligule a long thin Membrane.	Bristle Concave and Fleshy.	Bristle made by Folding of a Leaf-blade. Ligule reduced to Short Ears or Absent.			
Moor Mat Grass (*Nardus stricta*).  1. Thick cordlike roots. 2. Scale leaves. 3. Bud. 4. Base of an old bristle-blade—horizontal. 5. Thick ligule. 6. Young bristle leaves—erect.	**Wavy Hair Grass** (*Aira flexuosa*).  1. Leaf. *a*, Sheath; *b*, bristle-blade; *c*, ligule. 2. Magnified Section of Bristle-blade. *a*, The vascular bundles.	**Sea Meadow Grass** (*Poa maritima*).  1. Shoot. *a*, Sheath; *b*, bristle-blade. 2. Magnified Part of Leaf. *a*, Sheath; *b*, blade; *c*, ligule. 3. Magnified Section of the fleshy Blade.	**Sheep's Fescue** (*Festuca ovina*). Tufted grass with fine bristles.  1. Apical Part of Bristle-blade. 2. Magnified Part of Leaf. Ligule absent. *a*, Sheath; *b*, cartilaginous thickening or ears at base of blade; *c*, portion of bristle-blade made by folding.	**Hard Fescue** (*Festuca duriuscula*). Tufted grass with coarser bristles.	**Creeping Fescue** (*Festuca rubra*). Creeping growth. Base of shoot red-coloured.	**Various-leaved Fescue** (*Festuca heterophylla*). The ground leaves alone bristle-like.

GROUP 3.—SAND BINDERS, with Large *Hard* Blades

Blade Eared at Base.

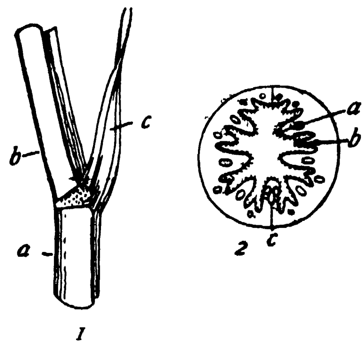
Sea Lyme Grass (*Elymus arenarius*).
Grows on sand wetted by the sea.



1. Portion of Blade.
   a, Sheath; *b*, base of blade; *c*, its pointed ears; *d*, ligule merely indicated.
2. Magnified Section of the Young Blade—rolled.

Blade Earless at Base.

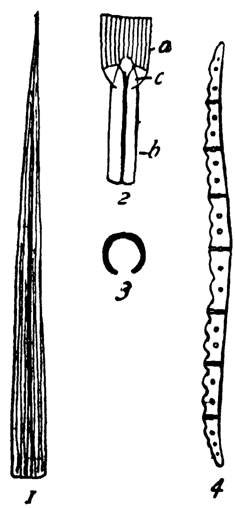
Sea Mat Grass (*Psamma arenaria*).
Grows on dry sand.



1. Portion of Leaf.
   a, Sheath; *b*, base of blade; *c*, long acute ligule split at point.
2. Magnified Section of Blade in Bud with Mixed Ribs.
   a, High rib; *b*, low rib; *c*, midrib.

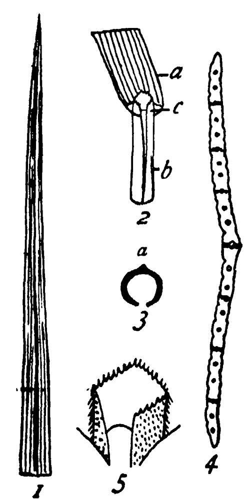
GROUP 4.—BULBOUS GRASSES (Top Grasses), with Blades having Flat Ribs and Rolled in Bud

Timothy (*Phleum pratense*).
A single 'bulb' at base of each shoot.



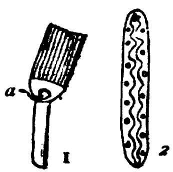
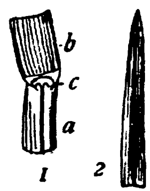
1. Apex of Blade.
2. Base of blade.
3. Section of Sheath—no Keel.
4. Magnified Section of Blade, showing the Flat Ribs on Upper Surface.
   a, Base of blade; *b*, sheath; *x*, ligule.

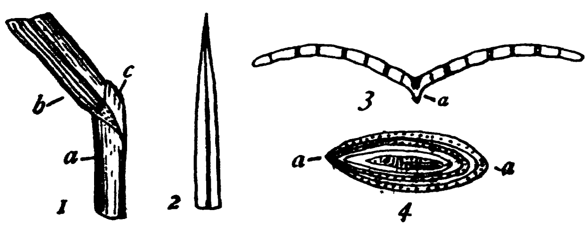
False Oat or Pearl Grass
(*Arrhenatherum avenaceum* var. *bulbosum*).
A row of 'bulbs' at the base of each shoot.



1. Apex of Blade.
2. *a*, Base of blade; *b*, sheath; *c*, ligule.
3. Section of Sheath, showing the Keel, *a*.
4. Section of Blade, showing the very low Flat Ribs.
5. Ligule magnified. The dots represent short hairs, best seen when the ligule is examined by transmitted light.

GROUP 5.—MEADOW AND PASTURE GRASSES, with Folded Leaf-blades and Shoots Flat. All are Bald.

TOP GRASS (with Broad Blades).	BOTTOM GRASSES (with Narrow Blades).						
Cocksfoot (*Dactylis glomerata*). (See figures below.)	Blades Ribbed.		Blades Ribless, with a Pair of Median Lines (fig. 17, 2).				
	Shoot Flat; its Base Red.	Underground Base of Shoot Yellow.	Texture of Blade Firm and Hard, therefore Dark-green by Transmitted Light.		Texture of Blade Soft and Herbaceous; therefore Light-green by Transmitted Light.		
					Sheath Flat.		Sheath Roundish rather than Flat.
1. Portion of Leaf. *a*, Sheath; *b*, base of blade; *c*, prominent ligule. 2. Acute Apex of Blade. 3. Magnified Section of the Ribless Leaf-blade. *a*, Keel. 4. Magnified Section across the flat shoot. *a*, Acute edges of sheath.	**Perennial Rye Grass** (*Lolium perenne*).  1. Portion of Leaf. *a*, The ears. 2. Magnified Section of the Folded Blade.	**Crested Dog's-tail** (*Cynosurus cristatus*).  1. Portion of Leaf. *a*, Sheath; *b*, base of blade; *c*, eared ligule. 2. Apex of Blade.	**Perennial Oat Grass** (*Avena pratensis*). Ligule with an abrupt acute point. Margins of blade very rough. Sheath round.	**Smooth-stalked Meadow Grass** (*Poa pratensis*). Ligule very short and thick. Sheath flat. Blade with parallel edges. (See fig. 15, 1.)	**Annual Meadow Grass** (*Poa annua*). Long blunt ligule. Blade not parallel-edged; its apex rounded; its lower surface dull. (See fig. 4.)	**Rough-stalked Meadow Grass** (*Poa trivialis*). Blade very fine, and tapered off to the acute apex; its lower surface very glossy. (See fig. 15 (2), and fig. 6.)	**Wood Meadow Grass** (*Poa nemoralis*). Blade with an acute apex. (See fig. 7.)



Cocksfoot (*Dactylis glomerata*). See description above.

GROUP 6.—MEADOW AND PASTURE GRASSES. Sheath with Characteristic Colour at its Underground Base

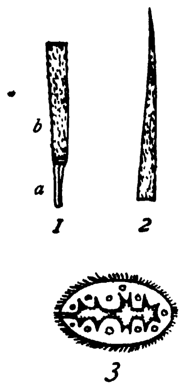
Top Grasses (with Broad Blades).				Bottom Grasses (with Narrow Flat Blades).	
Red.		Violet.	Red Veins in a White Ground.	Red.	Yellow.
Italian Rye Grass (*Lolium italicum*).	**Meadow Fescue** (*Festuca pratensis*).	**Meadow Foxtail** (*Alopecurus pratensis*).	**Yorkshire Fog** (*Holcus lanatus*). The only hairy grass in this group. (For figures see Group 9.)	**Perennial Rye Grass** (*Lolium perenne*). (See Group 5.)	**Crested Dog's-tail** (*Cynosurus cristatus*). (See Group 5.)

Note.—Some bristle-bladed grasses have the sheath red, *e.g.* Creeping or Red Fescue (*Festuca rubra*).

GROUP 7.—HAIRY GRASSES, with Flat Shoots and Folded Leaf-blades

Crested Kœleria
(*Kœleria cristata*).

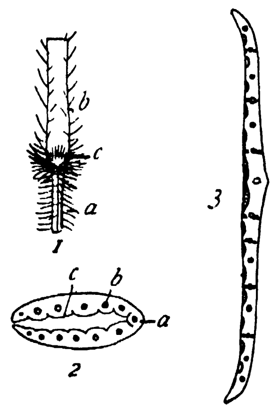
A small bottom grass of dry calcareous pastures.



1. Portion of Leaf.
   a, Sheath; *b*, base of blade, narrowed to base.
2. Pointed Apex of Blade.
3. Magnified Section of Folded Leaf-blade. Note the ribs very prominent, alternately high and low (mixed ribs).

Decumbent Heath Grass
(*Triodia decumbens*).

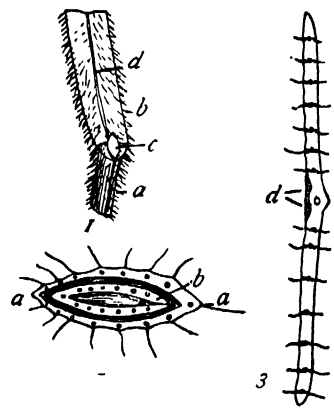
The only grass with flat sheath, folded blade, and ligule a tuft of hair.



1. Portion of Leaf.
   a, Flat sheath; *b*, base of blade; *c*, ligule a tuft of hair.
2. Magnified Section of the Folded Blade.
   a, Midrib; *b*, vascular bundle; *c*, very low flat ribs.
3. Magnified Section of the Leathery Blade.

Downy Oat Grass
(*Avena pubescens*).

Blade ribless, dry and thin, with a pair of median lines like Poa.



1. Portion of Leaf.
   a, Flat sheath; *b*, base of ribless blade; *c*, ligule with a sharp point; *d*, the pair of median lines.
2. Magnified Section of the Young Shoot.
   a, The two-edged sheath; *b*, the folded blade within.
3. Magnified Section of the Ribless Blade.
   d, The pair of median lines.

GROUP 8.—MEADOW AND PASTURE GRASSES, with Rolled Leaf-blades and Cylindrical Shoots. All Bald.

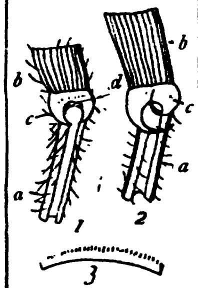
Top Grasses.					Bottom Grass.
Timothy (*Phleum pratense*). Base of shoot bulbous. (For figures see Group 4.)	**False Oat** (non-bulbous variety) (*Arrhenatherum avenaceum* var. *non-bulbosum*). Ligule dotted with hair. (For figures see Group 4.)	**Meadow Fescue** (*Festuca pratensis*). Shoot red at base. Margin of leaf-blade rough, especially at the base.	**Italian Rye Grass** (*Lolium italicum*). Shoot also red at base. The base of the leaf-blade has a smooth margin.	**Meadow Foxtail** (*Alopecurus pratensis*). Shoot with a creeping base, and coloured violet.	**Common Bent** (*Agrostis vulgaris*). Creeping growth. Ribs prominent. Ligule prominent. (See fig. 17, 1.)

GROUP 9.—HAIRY GRASSES, with Round Shoots and Rolled Leaf-blades

Leaf Base Eared.

Couch Grass (*Triticum repens*).

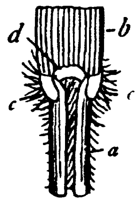
Ears like hooks. Ligule merely indicated.



1. Portion of Leaf.
   a, Sheath hairy; *b*, blade hairy; *c*, ears merely indicated; *d*, reduced ligule.
2. Portion of Leaf.
   a, Sheath hairy; *b*, blade bald; *c*, ears well developed as hooks.
3. The Rudimentary Ligule magnified.

Sweet Vernal (*Anthoxanthum odoratum*).

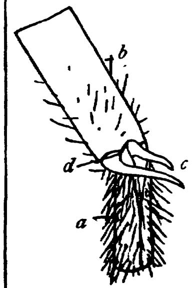
Ears rounded with a beard of hair. When the blade is chewed it has the characteristic taste of cumarin.



Portion of Leaf.
a, Sheath hairy; *b*, blade; *c*, the rounded ears with hair whiskers; *d*, ligule.

Rough Brome (*Bromus asper*).

Sheath unsplit, with a *white* prominent keel. Blades firm, long, and hanging.

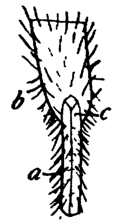


Portion of Leaf.
a, Sheath unsplit, with downward sloping hair; *b*, blade; *c*, pointed ears; *d*, ligule.

Leaf Base Earless.

Golden Oat Grass (*Avena flavescens*).

Ribs on blade low and acute; a single row of hair along the summit of each rib. No keel on the sheath.

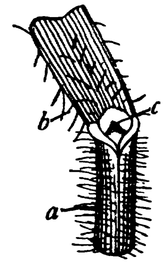


Portion of Leaf.
a, Sheath; *b*, blade; *c*, ligule.

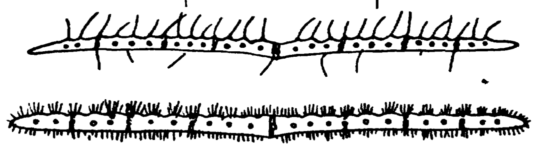
Magnified Section of Leaf-blade (see below). Note the sparse hair as compared with Yorkshire Fog.

Soft Brome (*Bromus mollis*).

Sheath entire and keeled. Ligule short.



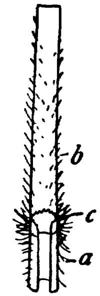
Portion of Leaf.
a, Entire sheath; *b*, blade; *c*, short ligule.



1, Magnified Section of Leaf-blade of Golden Oat Grass (*Avena flavescens*). 2, Magnified Section of Leaf-blade of Yorkshire Fog (*Holcus lanatus*).

Wood False Brome (*Brachypodium sylvaticum*).

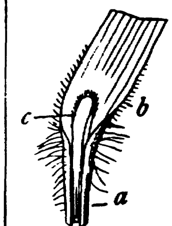
Blade thin, dry, and hanging. Toothed ligule.



Portion of Leaf.
a, Sheath; *b*, blade; *c*, long ligule with teeth.

Heath False Brome (*Brachypodium pinnatum*).

Blade rigid and erect. Ligule with a fringe of hair.



Portion of Leaf.
a, Sheath; *b*, base of blade; *c*, long ligule with a fringe of hair.

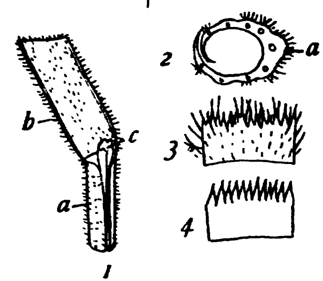
Yorkshire Fog (*Holcus lanatus*).

Sheaths white, with red veins.

The diagrams below show:—

1. Portion of Leaf.
   a, Sheath; *b*, blade; *c*, ligule.
2. Section of Keeled Sheath.
   a, The keel.
3. Magnified Ligule—outer view. Notice the hairs.
4. Magnified Toothed Ligule, showing the bald inner surface.

Magnified Section of Leaf-blade—densely hairy. See separate fig. (2).



Yorkshire Fog (*Holcus lanatus*). See description above.

XI. Grass Ears

The ear of a grass plant is constructed for the special purpose of reproduction; it is always situated at the end of the straw stem (culm).

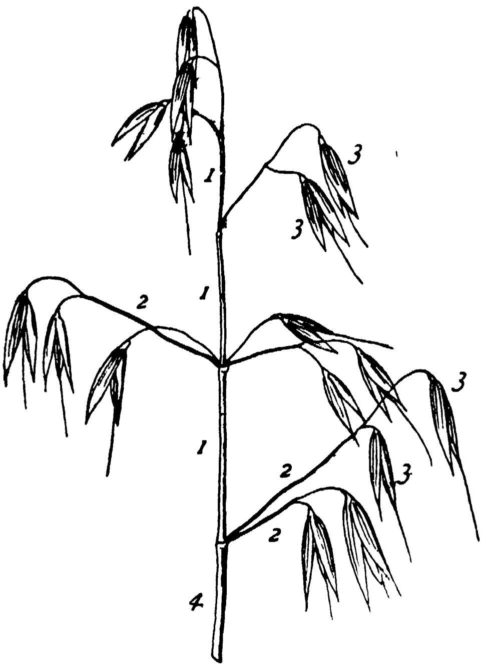


Fig. 20 —Panicle Ear of Common Oat

1, Axis of ear 2, Branches of this axis. 3, Spikelets. 4, Stalk of ear.

The parts of an ear are very readily distinguished on the cultivated oat: the three parts are—(1) axis, (2) branches of the axis, (3) spikelets. An ear so constructed is called *Panicle ear*; this ear form is further exemplified by Meadow Fescue, Meadow grasses (*Poa*), and many more. A second form of ear occurs in Wheat, Rye Grass, &c. In this case (fig. 21) there is (1) an axis, (2) no branches, (3) spikelets. The peculiarity of this ear is the absence of the branches of the axis. An ear so constructed is called a *Spike ear*. The bare part of the straw between the ear and the uppermost leaf is often called 'stalk', as in Rough-stalked Meadow Grass and Smooth-stalked Meadow Grass.

Grasses such as Timothy and Foxtail have the ear intermediate between panicle and spike, for the axis bears very short branches. In this case the ear looks more like a spike than a panicle, and accordingly such ears are described as *spikelike*, or more fully as *spikelike panicles*, and often as *cylindrical spikes*.

Spikelets.—The spikelet is the part of the ear which when young contains the flowers, and when old the grains. The main point is that these flowers are covered in by three sets of special leaves called—(1) glumes, (2) lower pales, and (3) upper pales. In grasses it is not the flowers that are externally visible, but the glumes and pales—hence the importance of these structures for purposes of distinction. These spikelet leaves are distinguished from each other by their position, as the following diagrams show. In fig. 22, A, the axis of the spikelet (1), bears two rows of flowers (2).

In B each flower is shown subtended by the special leaf marked 3, and called lower valve of the husk, or *lower pale* or *outer pale*.

In C an extra upper valve of husk, marked 4, has been added, and this valve is called *upper pale* or *inner pale*.

In D, two extra leaves, marked 5, have been added outside of all the rest, and such external leaves are called chaff or glumes, the one to the right (5_1) below the lowest flower called *lower glume*, and the one to the left (5_2) called *upper glume*. The parts of a grass spikelet are accordingly —(1) axis; (2) flowers; (3) lower pales, one per flower; (4) upper pales, one per flower; (5) two glumes, a lower and an upper. Since glumes and pales are for protective purposes, these parts are formed before the flowers. When the spikelet is ripe, each of its perfect flowers may have changed into a grain fruit; at this stage the spikelet contains grains instead of flowers, and presence or absence of grains is the chief difference between the spikelet ripe and the spikelet unripe.

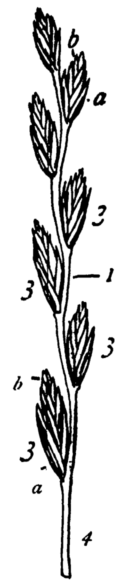


Fig. 21.—Spike Ear of Perennial Rye Grass

1, Axis of ear.
3, Spikelet.
4, Stalk of ear.
a, Glume.
b, Pales.

The number of flowers per spikelet varies. In fig. 22 the spikelet bears five flowers and

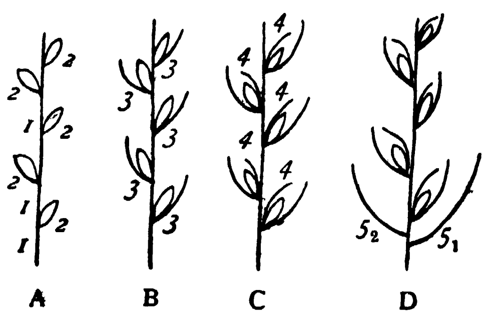


Fig. 22.—Component Parts of a Grass Spikelet (See accompanying description in text)

is called a *many-flowered* spikelet, indeed, the name 'many-flowered' is applied to all cases where there are more than three flowers per spikelet.

According to the number of flowers which they contain, the spikelets are: Many-flowered, if more than three, *e.g.* Rye grasses and Fescues; three-flowered, *e.g.* Golden Oat and Dog's-tail;

two-flowered, *e.g.* Hair grasses (Aira) and Yorkshire Fog; one-flowered, *e.g.* Foxtail, Timothy, and Bent (*Agrostis*).

In most cases, the number of flowers per spikelet is easily determined by counting the number of lower pales, since there is but one lower pale per flower. Sometimes, as in Timothy, Foxtail, and Yorkshire Fog, the glumes enclose and hide the pales; in such cases the number of flowers is reduced to one or two per spikelet. Such spikelets, of course, get the characters of importance for distinguishing species from the glumes, which are alone visible externally, whereas the many-flowered spikelets, with pales visible, get their characters rather from the conspicuous pales.

TABLE VII.—NUMBER OF FLOWERS PER SPIKELET

1. MANY-FLOWERED SPIKELETS—
   - (a) *Cultivated Top Grasses—*
     - **Cocksfoot**, **Meadow Fescue**, **Tall Fescue** — With panicle ear.
     - **Italian Rye Grass**—With spike ear.
   - (b) *Cultivated Bottom Grasses—*
     - **Smooth-stalked Meadow Grass**, **Rough-stalked Meadow Grass**, **Sheep's Fescue**, **Hard Fescue**, **Various-leaved Fescue**, **Creeping Fescue** — With panicle ear.
     - **Perennial Rye Grass**—With spike ear.
   - (c) *Water Grasses—*
     - **Floating Sweet Grass.**
     - Water Meadow Grass.
   - (d) *Weed Grasses—*
     - **'Hair Grass' (*Festuca Myurus*)**, **Brome grasses** — With panicle ear.
     - **Darnel Rye Grass**, **Couch Grass**, Wood Couch — With spike ear.
2. THREE-FLOWERED SPIKELETS—
   - **Golden Oat**, **Crested Dog's-tail** — With panicle ear.
3. TWO-FLOWERED SPIKELETS—
   - (a) *Cultivated—*
     - **Non-bulbous False Oat**
   - (b) *Weeds—*
     - Bulbous False Oat, Yorkshire Fog, Creeping Soft Grass, Tufted Hair Grass, Wavy Hair Grass
   - (all the above) With panicle ear.
4. ONE-FLOWERED SPIKELETS—
   - (a) *Cultivated Top Grasses—*
     - **Meadow Foxtail**, **Timothy** — Ear a cylindrical spike.
   - (b) *Cultivated Bottom Grasses—*
     - **Florin**—With panicle ear.
   - (c) *Weed Grasses—*
     - Water Foxtail, Sea Mat Grass—Sand binding — Ear a cylindrical spike.
     - Wall Barley, Moor Mat Grass — With spike ear.
     - Sweet Vernal, Common Bent, Reed Canary Grass — With panicle ear.

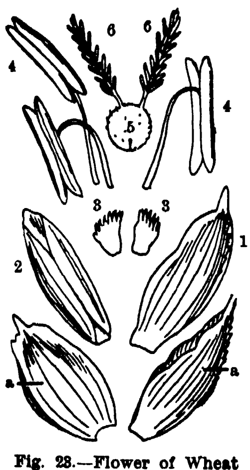


Fig. 23.—Flower of Wheat (*Triticum*): parts detached; also two pales and two glumes

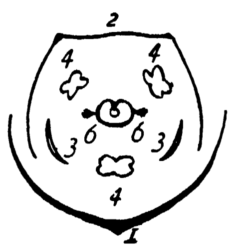


Fig. 24.—Floral Diagram of Wheat (*Triticum*)

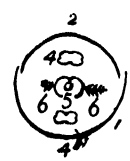


Fig. 26.—Floral Diagram of Sweet Vernal Grass

Fig. 25.—Flower of Sweet Vernal Grass: parts detached

In the figures, 1 is lower pale; 2, upper pale. (1 and 2 are merely the flower coverings, and not the flower itself.) 3, Perianth (lodicules), absent in Sweet Vernal. 4, Stamens (three in Wheat, two in Sweet Vernal). 5 and 6, Pistil. 5, Ovary with one ovule; 6, Two feathery stigmas, in Sweet Vernal brush-like, at the end of a naked stalk or style. *a*, Glumes.

THE GRASS FLOWER.—The flower of a grass (fig. 23) is enclosed between the two protecting pales—the lower and upper. It has a perianth reduced to a pair of minute membranous scales (lodicules), which are swollen only during the flowering period. There are, besides, three stamens and a pistil with two feathery stigmas.

Two kinds of flowers are distinguished: (1) The perfect flower (fig. 23) (hermaphrodite), in which the stamens and pistil are functional; and (2) the imperfect male flower (fig. 27), with stamens alone functional, and no pistil, or a mere functionless rudiment of one. The spikelet of Yorkshire Fog and of False Oat contains one

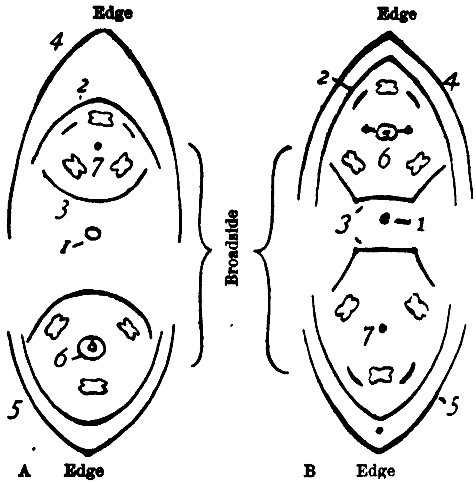


Fig. 27.—Diagram of Two-flowered Spikelet

A, Yorkshire Fog. B, Non-bulbous Tall Oat.
1, Axis of spikelet. 2, Lower pale. 3, Upper pale. 4, Upper glume. 5, Lower glume. 6, Pistil, marking the fertile flower. 7, The rudiment of the pistil, marking the barren flower. *Note.*—Yorkshire Fog with lower flower fertile; Tall Oat with upper flower fertile.

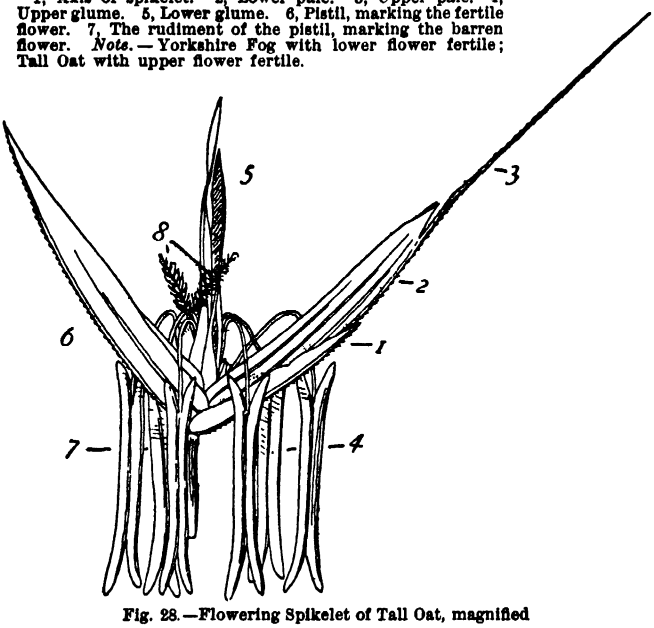


Fig. 28.—Flowering Spikelet of Tall Oat, magnified

1, Lower glume. 2, Lower pale of male flower. 3, Its awn. 4, Its three stamens. 5, Its upper pale. 6, Upper glume. 7, Three stamens of perfect flower. 8, Two feathery stigmas of perfect flower.

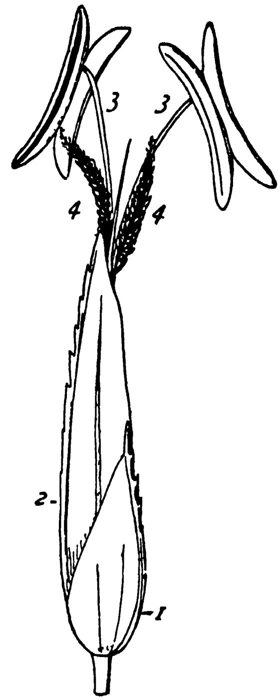


Fig. 29.—Flowering Spikelet of Sweet Vernal, magnified

1, Small lower glume. 2, Large upper glume. 3, The two stamens protruded from the apex. 4, The two brush stigmas protruded from the apex.

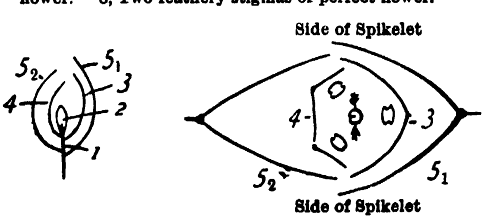


Fig 30.—Diagram of Timothy Spikelet (one-flowered)

1, Contracted axis. 2, Perfect flower, composed of three stamens, one-ovuled ovary, and two brush stigmas on long styles. 3, Lower pale, overlapping 4, the upper pale. 5_1, Lower glume, overlapping 5_2, the upper glume. This spikelet is compressed laterally.

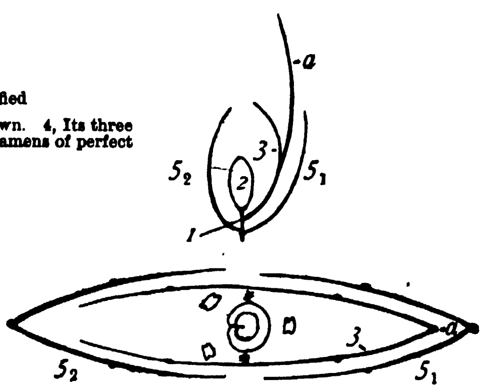


Fig. 31.—Diagram of Flat One-flowered Spikelet of Meadow Foxtail

1, Contracted axis. 2, Perfect flower. . 3, Lower pale awned (*a*) from the back. Upper pale absent. 5_1, Lower glume. 5_2, Upper glume.

perfect flower and one male flower, as shown in fig. 27.

The flowering goes on in three ways: (1) The pales open, and the stamens hang out between the open pales, *e.g.* Tall Oat (fig. 28) and most grasses; (2) the pales only open slightly, and the stamens and brush-like stigmas protrude from the apex of the spikelet, *e.g.* Timothy, Foxtail, and Sweet Vernal (fig. 29) (lodicules are superfluous here, and either disappear or remain rudimentary); (3) the pales never open, and the stamens never protrude (cultivated Oat often, Barleys, &c.). No Meadow or Pasture grass adopts this third plan.

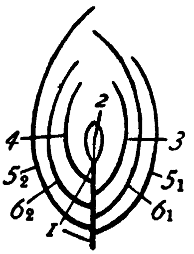


Fig. 32.—Diagram of Spikelet of Sweet Vernal

1, Axis of Spikelet. 2, Perfect flower. 3, Lower pale. 4, Upper pale. 6_1 Lower inner glume. 6_2, Upper inner glume. 5_1, Lower outer glume overlapping 5_2 upper outer glume.

Names used in Floras.—One of the chief difficulties in reading botanical works on grasses is connected with the terms used in describing the parts of the ear and of the spikelet. These special terms are here tabulated:—

Rachis	= **Axis of ear.**
Rachilla	= **Axis of spikelet sometimes only a part of axis.**
Empty glumes	= Glumes.
Flowerless glumes	= Glumes.
Flowering glume	= Lower pale.
Glumella	= Lower pale.
Glumellas	= Lower + upper pale.
Lower glumella	= Lower pale.
Outer glumella	= Lower pale.
One-nerved scale	= Lower pale.
Inner glumella	= Upper pale.
Palea	= Upper pale.
Two-nerved scale	= Upper pale.
Floret	= Lower pale + upper pale + flower proper.
Scales	= Perianth of flower.
Lodicules	= Perianth of flower.
Caryopsis	= Grain fruit.
Pericarp	= Outer part of the skin of the grain.
Glumellas adhere to seed	= Grain enclosed within its two pales.
Perfect floret	= Flower with stamens and pistil.
Two-sexual flower	= Flower with stamens and pistil.
Imperfect flower	= Flower with stamens only and no pistil.
Male flower	= Flower with stamens only.

The following diagrams show further how these technical terms are applied to the spikelet:—

Fig. 33.—Diagrams Illustrating Parts of the Spikelet and Terms used to describe them

1, Rachilla or axis of Spikelet. 2, Flower proper. 3, Lower pale = Glumella = Flowering Glume = Lower Glumella = Outer Glumella = One-nerved scale. 4, Upper Pale = Palea = Upper Glumella = Inner Glumella = Two-nerved scale. Floret = 2, 3, and 4 together. 5, Empty glume = Glumes (5_1, Lower glume. 5_2, Upper glume). 6, Inner glumes = Inner empty glumes (6_1, Lower inner glume. 6_2, Upper inner glume).

XII. How to know Grasses by the Ears

According to the character of the ear, there are two divisions of grasses:—

Division A, with Spike Ears.

Division B, with Panicle Ears, including all those grasses in which the axis of the ear is distinctly branched.

Division A includes three groups:—

Group 1.—Spike one-sided: all the spikelets are confined to one side of the axis, leaving the other side quite bare.

Group 2.—Spike two-rowed: all the spikelets are arranged in two rows along the axis of the ear (fig. 21).

Group 3.—Spike cylindrical (often called a cylindrical spikelike panicle): the spikelets overlap and surround the axis of the ear so as to hide it completely.

Division B includes four groups:—

Group 4.—Bristle-bladed grasses.

Group 5.—Water reed grasses.

Group 6.—Top grasses, marked by the broad leaf-blades.

Group 7.—Bottom grasses, marked by the narrow flat (not bristle-like) leaf-blades.

DIVISION A.—SPIKE-EARED GRASSES

Group 1.—Ear a One-sided Spike

Moor Mat Grass (*Nardus stricta*).	**Crested Dog's-tail** (*Cynosurus cristatus*).
Leaves bristle-like.	Flat-bladed Bottom Grass. Base of shoot coloured yellow.

Group 2.—Ear a Two-rowed Spike (fig. 21)

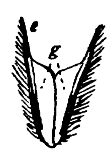
A. *Spikelets Solitary*

Cereals.		A Shade Grass.	A Heath Grass.	Axis of Ear with Two Rows of Notches.					
				Spikelet Seated in the Notch with its Edge next the Axis of the Ear.			Spikelet Seated in the Notch with its Broadside next the Axis of the Ear.		
Rye. With narrow glumes.	**Wheat.** With broad glumes.	**Slender False Brome** (*Brachypodium sylvaticum*). Ear nodding. Spikelet cylindrical, with a very short stalk and long awns.	**Heath False Brome** (*Brachypodium pinnatum*). Ear stiff and erect. Spikelet cylindrical with the awn quite short.	**Perennial Rye Grass** (*Lolium perenne*). No awns. Bottom grass.	**Italian Rye Grass** (*Lolium italicum*). Awns. Top grass.	**Darnel Rye Grass** (*Lolium temulentum*). The glume on the outer edge as long as the spikelet. Annual. Seeds often poisonous from the presence of a parasitic fungus.	**Common Couch** (*Triticum repens*). Hairy. Creeping.	**Sea Couch** (*Triticum junceum*). Waxy. Creeping.	**Fibrous Couch** (*Triticum caninum*). Hairy. Tufted.

B. *Spikelets not Solitary: in Tufts of Three (Triplets), sometimes in Twos or in Fours*

Cultivated Barley.	**Wall Barley** (*Hordeum murinum*). An annual on dry sand.	**Sea Barley** (*Hordeum maritimum*). Waxy (glaucous). By the sea.	**Meadow Barley** (*Hordeum pratense*). On open dry meadows.	**Sea Lyme Grass** (*Elymus arenarius*). A sand binder. Stands sea spray and sea water. Ear looks like a cylindrical spike.

Group 3.—Ear a Cylindrical Spike (egg-shaped in Canary Grass)

A Sand Binder.	Cultivated Permanent Top Grasses.		Annuals.	
Sea Mat Grass (*Psamma arenaria*). Earless leaf base. On dry sand by the sea. The Sea Lyme (Group 2, B) grows on the wet sand, and has an eared leaf base.	**Timothy** (*Phleum pratense*). Spikelet with 2 blunt-pointed glumes (*g*), having an earlike prolongation (*e*). 	**Meadow Foxtail** (*Alopecurus pratensis*). Ear soft to the touch. Spikelet with pointed glumes, downy hair, and a fine awn. 	**Slender Foxtail or Black Grass** (*Alopecurus agrestis*). Ear a slender and pointed cylinder, almost bald.	**Canary Grass** (*Phalaris canariensis*). Ear broad and egg-shaped.

DIVISION B.—PANICLE EARS (figs. 4 and 20)

Group 4.—Bristle-bladed Grasses: on Sands

Ligule 0: Awn from Apex of Lower Pale.				Ligule Present: Awn from Back of Pale.		
Sheep's Fescue (*Festuca ovina*). Awn short or absent.	**Hard Fescue** (*Festuca duriuscula*). Awn long.	**Various-leaved Fescue** (*Festuca heterophylla*). Leaves on straw open and flat.	**Creeping Fescue** (*Festuca rubra*). Creeping growth. Shoot base red.	**Wavy Hair Grass** (*Aira flexuosa*). Perennial, 12–18 in. high.	**Silvery Hair Grass** (*Aira caryophyllea*). Annual, 6 in. high.	**Early Hair Grass** (*Aira præcox*). Annual, 3 in. high, spring flowering, with a spike-like ear.

Group 5.—Water Reed Grasses with Broad Leaves

Common Reed (*Phragmites communis*). 5 or 6 ft. high. Ligule a hair tuft. Round shoots.	**Reed Canary Grass** (*Phalaris canariensis*). Round shoots. Ear like that of Cocksfoot, but with the spikelets covering the tips of the branches (not confined to one side).	**Water Meadow Grass** (*Poa aquatica* or *Glyceria aquatica*). Flat shoots. Spikelet short, not cylinder-shaped.	**Floating Sweet Grass** (*Glyceria fluitans*). Flat shoots. Spikelet cylinder-shaped.

Group 6.—Top Grasses with Broad Blades

A. *Hairy Grasses. Sheath White with Red Veins. Spikelets quite Flat, the Glumes hiding the Pales.*

Yorkshire Fog (*Holcus lanatus*). Knot on straw hairy all over.	**Creeping Soft Grass** (*Holcus mollis*). Knot on straw with a downward sloping ring of hairs. An awn projects from the spikelet.

B. *Pales Exposed, Awnless, or at most with an Awnlike Point.*

Meadow Fescue (*Festuca pratensis*). Point of lower pale a membrane (which readily frays), and blunt.	**Tall Fescue** (*Festuca elatior*). Point of lower pale firm and sharp.	**Cocksfoot** (*Dactylis glomerata*). The spikelets are in one-sided tufts at the apex of the branches of the ear. Flat shoots.

C. *Awn from a Notch in the Apex of the Pale* (*Brome Grasses with Closed Sheath*)

Soft Brome (*Bromus mollis*). Spikelets hairy.	**Rye Brome** (*Bromus secalinus*). Spikelets bald, heavy, and hanging to one side of the long ear. Edges of lower pales curled inwards.	**Field Brome** (*Bromus arvensis*). Spikelets bald, each branch of the short ear bearing but one or two violet spikelets.	**Rough Brome** (*Bromus asper*). With eared leaf base; very hairy.	**Barren Brome** (*Bromus sterilis*) Branches of the panicle long and drooping.	**Great Brome** (*Bromus maximus*) Branches of the panicle short and erect. Spikelet, including the awns, 3 in. long.

D. *Awn from Back of Pale. Spikelets large, like those of an Oat*

		Tall Annual Weeds in Corn.	
False Oat (bulbous variety) (*Arrhenatherum avenaceum* var. *bulbosum*). Base of shoot with rows of 'bulbs'. Knot on straw hairy.	**False Oat** (non-bulbous variety) (*Arrhenatherum avenaceum* var. *non-bulbosum*). No 'bulbs'. Knot on straw bald.	**Wild Oat** (*Avena fatua*). Taller than Cultivated Oat. Hairy spikelets, ¾ in. long, with three awns.	**Shetland or Bristle Oat** (*Avena strigosa*). Two awns per spikelet. (In Cultivated Oat there is never more than one awn per spikelet.)

Group 7.—Bottom Grasses

A. *Spikelets very small—One-flowered = Bent Grasses*

Common Bent (*Agrostis vulgaris*).	**Fiorin or Creeping Bent** (*Agrostis stolonifera*)	**Brown Bent** (*Agrostis canina*).	**Silky Bent** (*Apera spica venti*).
Ligule short and blunt; ear darkish; open after flowering.	Ligule long and acute; ear whitish; closed after flowering.	Leaves very narrow; spikelets awned.	An annual corn weed. Awn four times as long as the spikelet.

B. *Spikelets small—Two-flowered, with Two Basal Awns*

Tufted Hair Grass (*Aira cæspitosa*).
Leaf very rough, with seven very high acute ribs.

C. *Spikelets Three-flowered, no Awns*

Crested Kœleria (*Kœleria cristata*).	**Purple Molinia** (*Molinia cærulea*).	**Decumbent Heath Grass** (*Triodia decumbens*)
Ear spikelike, about 2. in. long, with silvery spikelets. A low (6 in. high) hairy grass; blade folded in the bud and taper-based, with prominent mixed ribs. A potash indicator.	Ear narrow, with branches erect, and purplish spikelets. A tall (3 ft. high) moor grass; the ground leaves taper-based, with ligule a tuft of hair, and upper surface of blade hairy. Late flowering.	A low tufted heath grass. Lower pale, with three minute teeth. Ligule a hair tuft.  Lower Pale with Three Teeth (magnified).

D. *Spikelets larger—Three-flowered, with Three Awns from the Backs of the Pales (only Two Awns in Shetland Oat)*

Golden Oat Grass (*Avena flavescens* or *Trisetum flavescens*)	**Perennial Oat Grass** (*Avena pratensis*)	**Downy Oat Grass** (*Avena pubescens*)
Hairy grass on calcareous soils. Spikelet glossy yellow, about ¼ in. long.	Bald grass on calcareous soils. Spikelet glossy, reddish, ½ in. long. Leaf like Poa—folded and ribless.	Like the former, but hairy.

E. *Spikelets many-flowered, Awnless.*

Point of Pale Acute. Spikelet Small and Egg-shaped. Meadow Grasses (Poa).				Point of Pale Rounded. Spikelet Larger and Heart-shaped.	
Annual Meadow Grass (*Poa annua*)	**Wood Meadow Grass** (*Poa nemoralis*)	**Smooth-stalked Meadow Grass** (*Poa pratensis*)	**Rough-stalked Meadow Grass** (*Poa trivialis*)	**Quaking Grass** or **Silver Shekels** (*Briza media*)	**Lesser Quaking Grass** (*Briza minor*)
A low annual, in flower all the year.	Uppermost leaf with very short ligule. Knot short and black.	Uppermost leaf with short, blunt ligule. Sometimes the spikelets contain few flowers.	Uppermost leaf with long, pointed ligule. Knot on straw, strong, white, and long.	Spikelet heart-shaped, hanging ligule very short.	An annual, distinguished from preceding by the very long ligule, and the spikelets smaller.

XIII. Grass Seeds

These so-called seeds are never really seeds. A grain of wheat, for example, is a seed en-

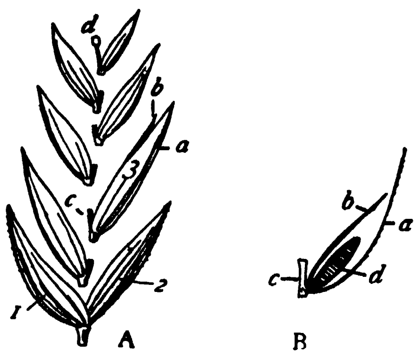


Fig. 34

A, Diagram of a Grass Spikelet broken up into 'seeds'. 1, Lower glume of chaff. 2, Upper glume of chaff. 3, A seed. [Parts of the seeds. *a*, Back valve of husk (lower pale). *b*, Inner valve of husk (inner pale). *c*, Stalk on inner face. *d*, Rudiment only on end seed.]

B, Longitudinal section of a grass seed, showing the grain *d* enclosed between the two valves of the husk.

closed within a thin transparent seedcase (pericarp) which adheres to the seed within, and consequently the whole of the seedcase and the seed together constitutes a fruit, a grain fruit, kernel, or *caryopsis* as it is technically called (fig. 1). Again, Rye Grass seed or Meadow Fescue seed is not a true seed, but a detached portion of the spikelet (fig. 34) composed of a two-valved husk (two pales) enclosing within it the grain fruit or caryopsis. On one face there is a stalk (rachis), a disarticulated part of the axis of the spikelet, and this *stalk* marks the *inner face* of the seed, the other face being called the *back* of the seed. This breaking up of the spikelet into distinct pieces for purposes of reproduction occurs naturally when the ear is ripe, and so a sample of

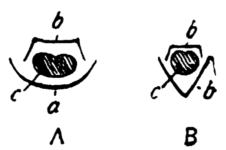


Fig. 35

A, Section of round-backed seed. B, Section of V-backed seed. *a*, Lower pale forming back. *b*, Upper pale forming inner face. *c*, Enclosed grain.

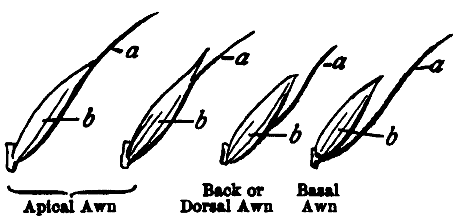


Fig. 36.—*a* is the Awn, *b* the Lower Pale.

grass seed with imperfectly disarticulated spikelets is a certain sign of immaturity and deficiency of grain, as is frequently the case in samples of Cocksfoot (fig. 42). For purposes of distinction it is important to notice the character of the back (lower pale) of these detached pieces. In certain grasses the back is rounded off (fig. 35, A), so that the seed can lie on its back — for example, Rye Grass. In other grasses the back is not rounded but V-shaped—for example, Cocksfoot (fig. 35, B). Such a seed lies on its side, like a boat stranded on the beach, and cannot lie on its back. The importance of this distinction comes from this, that it is very easy to notice whether a grass seed is lying on its side or on its back, and so to distinguish seeds otherwise closely resembling one another. Another point easy to notice is whether the piece of the spikelet has a beard (awn) or not. If the awn is present it may spring from the apex of the lower pale, or from its back, or even from the very base of the pale (fig. 36). As examples we may take Italian Rye Grass, with an *apical awn*, Oat grasses of all sorts, with a back or *dorsal awn*, and Hair Grass (Aira), with a *basal awn*. The varieties of grass seed construction are not yet exhausted, for there is a whole group of grass seeds constructed not merely of

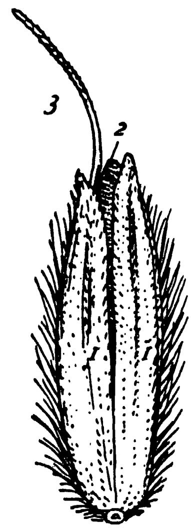


Fig. 37.—Magnified Seed of Meadow Foxtail

1, Glumes. 2, Point of lower pale. 3, Projecting part of awn.

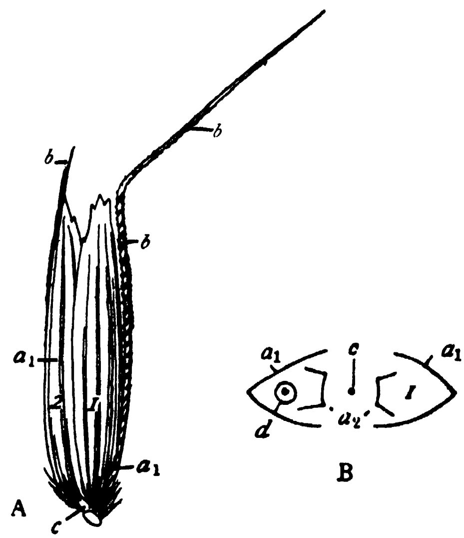


Fig. 38.—Double Seed of Tall Oat (magnified)

A, Longitudinal view. B, Transverse section. 1, Barren part. 2, Fertile part. a_1, Lower pale. a_2, Upper pale. *b*, Awn. *c*, Short axis of spikelet.

a detached part of the spikelet, but of the spikelet in its entirety. Such are Meadow Foxtail seeds and Yorkshire Fog seeds (figs. 37 and 39). The external part, in such cases, is not the husk

of pales, but the chaff of *glumes*. These spikelet 'seeds' are very easy to recognize by their two-valved chaff (glumes), and by their excessive flatness, which forces them to lie on their broad face. Other special cases occur, to which special names are applied. Thus the seed of Tall Oat or Pearl Grass is called a 'double seed' because it is composed of the two flowers of the spikelet, that is the whole spikelet minus the two glumes (fig. 38). Such a seed does not contain two grains, but only one, since the first flower is staminate and barren, without the power of producing a grain. Yorkshire Fog shows the same construction when the two glumes of its spikelet happen to be removed by threshing or by the hand (fig. 39, B). The 'double seed' is then exposed, and this, like the seed of False Oat, contains but a single grain, since one of the two component flowers—the second in this case—is barren. In Yorkshire Fog the breaking-up process is often carried further, and the barren part is detached from the fertile part containing the grain. Thus is produced 'shelled Holcus', a very harmless-looking minute white glossy body like Timothy seed, but though so harmless in appearance, capable of producing one of the most troublesome weeds of our pastures and meadows, namely Yorkshire Fog. The barren part with the hook awn is most characteristic of Yorkshire Fog.

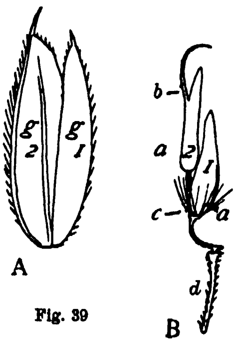


Fig. 39

A, Seed of Yorkshire Fog. B, The same with glumes removed (magnified). g_1, Lower glume overlapping g_2, upper glume. 1, Fertile awnless part. 2, Barren part with hook awn *b*. *a*, Lower pale. *c*, Seed stalk. *d*, Stalk of spikelet.

One other case remains for notice, namely the shelled seeds of Timothy and Cocksfoot. These shelled seeds are merely the grains or kernels from which the husk of pales has been removed by threshing (fig. 1).

XIV. How to know Grasses by their Seeds

According to their construction, grass seeds may now be grouped thus:—

Group 1.—The seed is THE WHOLE SPIKELET.
Group 2.—The seed is A ROUND-BACKED PORTION of the spikelet. (Lower pale rounded.)
Group 3.—The seed is a V-BACKED PORTION of the spikelet. (Lower pale keeled).
Group 4.—The seed is a portion of the spikelet with A BACK OR A BASAL AWN.
Group 5.—DOUBLE SEEDS.
Group 6.—SHELLED SEEDS.
Group 7.—SEED WITH EXTRA INNER GLUMES. In this rare case the spikelet is peculiarly constructed, having not only an outer pair of glumes, but an extra inner pair, which go along with the detached portion called 'seed'. Examples are Sweet Vernal Grass (fig. 32) and Reed Canary Grass.

It is easy to subdivide these seed groups by taking size into account. If, for example, some seeds of Italian Rye Grass are sprinkled over a sheet of millimetre paper, we at once see the length of the seed. The body of the seed, *i.e.* the swollen part, measures 6 or 7 mm., and the awn at the apex 4 or 5 mm. more. The awn, if present, should have its length stated separately from that of the body of the seed, for the awn is liable to have its point broken off, and besides it varies much in length. In seed group 1, the simplest plan is to measure the length of the projecting part of the awn, and neglect the part hidden by the glume covers. For convenience, the seeds are called *long* when the body exceeds 7 mm., *medium* when it exceeds 5 mm., and *short* when the length is less than 5 mm. The following table shows the results of such measurements. The seeds of cultivated species are printed in thick type:—

A.—LONG SEEDS (belong to Groups 2, 3, 4, and 5): exceed 7 mm.

Group 2 (Round-backed Portions of the Spikelets)

Length in Millimetres		Common Name.	Technical Name.	Remarks.
Body of Seed.	Awn.			
18	18	Barren Brome.	*Bromus sterilis.*	Back with seven ribs.
13	3	Rough Brome.	*Bromus asper.*	Hairy; very narrow.
10	0–2	Couch Grass.	*Triticum repens.*	Seed stalk narrows towards the base.
10	40	Wall Barley.	*Hordeum murinum.*	One seed per spikelet.
9	9	Wood False Brome.	*Brachypodium sylvaticum.*	
9	1½	Heath False Brome.	*Brachypodium pinnatum.*	Hairy surface.
9	7	**Upright Perennial Brome.**	*Bromus erectus.*	Stalk with short rough hair.
8	10	Meadow Barley.	*Hordeum pratense.*	Only one seed per spikelet.
5–8	0–8	Darnel Rye Grass.	*Lolium temulentum.*	Poisonous.
8	8	Wood Couch.	*Triticum caninum.*	
7	0–3	Rye Brome.	*Bromus secalinus.*	Elliptical outline edges curled in, and bald surface (fig. 41).
7	5	Soft Brome.	*Bromus mollis.*	Broad at apex, narrow at base, and hairy surface (fig. 41).

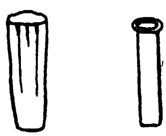
A.—LONG SEEDS (*Continued*).

Length in Millimetres. Body of Seed.	Length in Millimetres. Awn.	Common Name.	Technical Name.	Remarks.
7	0	Common Reed.	*Phragmites communis.*	Seed immersed in long hairs.
7	0	**Rhenish Tall Fescue.**	*Festuca elatior*	Cylindrical stalk.
7	1	New Zealand Tall Fescue.	*Festuca arundinacea*	
7	0	**Perennial Rye Grass.**	*Lolium perenne*	Seed stalk flat, broad at apex, narrow at base.
7	6	**Italian Rye Grass.**	*Lolium italicum*	
		Group 3 (V-*backed Portions of the Spikelets*)		
18	0	**Schrader's Brome.**	*Bromus Schraderi.*	
		Group 4 (*Seed with Awned Back*)		
Stiff hairs on the seed stalk 15	30	Wild Oat.	*Avena fatua.*	Yellow basal hairs.
13	16	Perennial Oat Grass.	*Avena pratensis.*	
12	16	Downy Oat Grass.	*Avena pubescens.*	
		Group 5 (*Double Seeds*)		
9	12	Tall Oat. (The non-bulbous variety is cultivated.)	*Arrhenatherum avenaceum.*	There are two awns per seed, and 12 mm. is the length of the long bent one (fig. 38).
		B.—MEDIUM SEEDS (belong to Groups 1, 2, and 3): exceed 5 mm.		
		Group 1 (*the Spikelet is the Seed*)		
Awned 6	4	Slender Foxtail	*Alopecurus agrestis.*	Glumes bald, awn stiff.
5	2	**Meadow Foxtail.**	*Alopecurus pratensis.*	Glumes hairy, awn fine (fig. 37).
5	2	Creeping Soft Grass.	*Holcus mollis.*	
		Group 2 (*Round-backed Portions of the Spikelets*)		
Awned 6	2	Moor Mat Grass.	*Nardus stricta*	Stalk cylindrical.
6	4	**Various-leaved Fescue.**	*Festuca heterophylla*	
6	2	**Creeping Fescue.**	*Festuca rubra*	
5	12	'Hair Grass.'	*Festuca Myurus*	
Awnless 6	0	**Meadow Fescue.**	*Festuca pratensis*	
5	0	Floating Sweet Grass.	*Glyceria fluitans*	Might be placed with the short seeds.
5	0	Smooth Heath Grass.	*Triodia decumbens*	
		Group 3 (V-*backed Portions of the Spikelets*)		
5	½-1	Cocksfoot.	*Dactylis glomerata.*	White husk and bent point (fig. 42).
		C.—SHORT SEEDS (Groups 1, 2, 3, 4, 6, and 7): less than 5 mm.		
		Group 1 (*the Spikelet is the Seed*)		
4	0	Yorkshire Fog (unshelled).	*Holcus lanatus.*	Fig. 39, A.
3	3	Water Foxtail.	*Alopecurus geniculatus.*	
		Group 2 (*Round-backed Portions of the Spikelets*)		
4	12	Hair Fescue or Hair Grass.	*Festuca Myurus.*	Body exceedingly slender; awn often broken (fig. 42).
4	4	**Hard Fescue.**	*Festuca duriuscula*	Stalk cylindrical.
4	0-1	**Sheep's Fescue.**	*Festuca ovina*	
4	0-1	**Crested Dog's-tail.**	*Cynosurus cristatus.*	Yellow or brown, dotted with short bristles towards the bent point.
3	0	Quaking Grass.	*Briza media.*	Length equal to breadth, hollow like a shell, and no stalk.
2	2	Brown Bent.	*Agrostis canina.*	
2	0-1	Common Bent.	*Agrostis vulgaris.*	
2	0-1	**Fiorin.**	*Agrostis alba.*	
2	0	**Timothy.**	*Phleum pratense.*	Silvery husk. This seed is rotund, and rolls like a ball when placed on a smooth surface.

Length in Millimetres. Body of Seed.	Awn.	Common Name.	Technical Name.	Remarks.
		Group 3 (V-backed Portions of the Spikelets; no Awn)		
3½	0	Purple Molinia.	*Molinia cærulea.*	Husk of pales gaping at the point (fig. 44).
3½	0	Annual Meadow Grass.	*Poa annua.*	
2½	0	**Smooth-stalked Meadow Grass.**	*Poa pratensis.*	Slender stalk.
2½	0	**Rough-stalked Meadow Grass.**	*Poa trivialis.*	Stalk twice as stout.
2½	0	**Wood Meadow Grass.**	*Poa nemoralis.*	No hairs at base.
		Group 4 (Seed with Awned Back or Base)		
4	5	**Golden Oat.**	*Avena flavescens.*	Awn from back. Stalk feather-like, with upward sloping hair (fig. 45).
4	5	Wavy Hair Grass.	*Aira flexuosa.*	Awn from base (fig. 46).
2½	4	Tufted Hair Grass.	*Aira cæspitosa.*	Awn from base. Hairy at the base and along the stalk.
2½	10	Silky Bent.	*Apera spica venti.*	Awn from near apex.
		Group 6 (the Seed is the Naked Grain)		
2½	—	Floating Sweet Grass.	*Glyceria fluitans.*	Grain circular in section.
2	—	**Cocksfoot.**	*Dactylis glomerata.*	Grain triangular in section, with a flat face.
1¾	—	**Timothy.**	*Phleum pratense.*	Grain circular in section.
		Group 7 (Seeds with Extra Inner Glumes, fig. 32)		
3½	3	**Sweet Vernal Grass.**	*Anthoxanthum odoratum.*	Hairy reddish-brown surface formed by the pair of inner glumes, each with an awn.
3½	0	Reed Canary Grass.	*Phalaris arundinacea.*	Two hair tufts at the base representing the pair of inner glumes.

XV. Impurities and Adulterants of Commercial Seed

Since this article deals solely with grasses, the only impurities and adulterants mentioned belong to the order Gramineæ. Of course, other impurities occur, but these are not dealt with here.



1 2

Fig. 40

1, Flat Stalk of Perennial Rye Grass. 2, Cylindrical Stalk of Meadow Fescue.

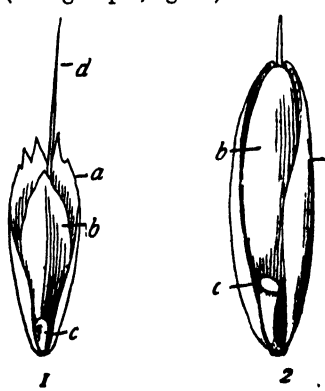
SEED GROUP 1.—The seed is the whole spikelet.

Meadow Foxtail (fig. 37).—Unripe seed has a light-coloured husk (glumes); when ripe the seed is darker, and greyish-yellow. The impurities are: Meadow grasses (Poas, seed group 3), and Tufted Hair Grass (seed group 4). The adulterants are Slender Foxtail, Creeping Soft Grass, and Yorkshire Fog (fig. 39), all belonging to seed group 1.

SEED GROUP 2.—The seed is a round-backed portion of the spikelet.

Italian Rye Grass.—The presence of the awn distinguishes this from Perennial Rye Grass. The common impurities are Yorkshire Fog (seed group 1) and Hair Fescue Grass (*Festuca Myurus*, seed group 2, fig. 42).

Perennial Rye Grass.—The common impurities are Yorkshire Fog (seed group 1) and Soft Brome (seed group 2, fig. 41).



1 2

Fig. 41

1, Soft Brome Seed (magnified), from inner face. *a*, Lower pale. *b*, Upper pale. *c*, Stalk. *d*, Awn from notched apex. 2, Rye Brome Seed (magnified), from inner face. *a*, Lower pale. *b*, Upper pale. *c*, Stalk.

Meadow Fescue.—**This is distinguished from Perennial Rye Grass by the stalk (fig. 40), which**

is cylindrical with a flange at the apex, not flat and not narrowed to the base. The common impurities are Soft Brome and Rye Brome (fig. 41) of seed group 2. An adulterant is Perennial Rye Grass.

Rhenish Tall Fescue. — This differs from Meadow Fescue in two points — the colour is darker, and the point of the husk is never broken; the size also is slightly greater. A common impurity is Cocksfoot (seed group 3, fig. 42), and a common substitute is New Zealand Tall Fescue (seed group 2).

New Zealand Tall Fescue. — This differs from Rhenish Tall Fescue in two points—the colour is light, as in Cocksfoot, and there is a very short awn point.

Hard Fescue. — This is distinguished from Sheep's Fescue by its larger size and long awn. The common impurities are Purple Molinia (seed group 3, fig. 44) and Wavy Hair Grass (seed group 4, fig. 45).

Sheep's Fescue has at most a trace of an apical awn. Hard Fescue is often substituted for this species.

Seed Group 3.—The seed is a V-backed portion of the spikelet.

1 2

Fig. 42

1, Seed of Cocksfoot, showing bent point. 2, Seed of Hair Grass (*Festuca Myurus*): nat. size.

Cocksfoot. — In immature samples the seeds are often 'double' (fig. 42) on account of immaturity. There is a characteristic *bend to the side* at the point of this seed. The common impurities are Yorkshire Fog (seed group 1) and Soft Brome (seed group 2). Adulterants are Perennial Rye Grass and Hard Fescue, both belonging to seed group 2.

Meadow Grass seeds (*Poa*) may be distinguished thus:—

	Rough-stalked Meadow Grass.		Smooth-stalked Meadow Grass.
Stalk of seed.	Very slender.	......	Twice as thick, and shorter.
Rudiment at end of stalk.	Globular.	......	Long and pointed.

Note.—This rudiment occurs only on the end 'seed' of the spikelet (fig. 34).

Adulterants of Meadow grasses are Purple Molinia (seed group 3), and Hair grasses (Aira) with a basal awn (seed group 4, fig. 45). There are never awns on Poa seeds.

Crested Dog's-tail.—This seed ends in a hard sharp point, which is *bent to the side* like the point of a Cocksfoot seed. The stalk is a short cylinder ending in a disklike flange.

Fig. 43.—Shelled Holcus (× 6)

1, Barren part. *a*, Hook awn. *b*, Lower pale. 2, Fertile part. *b*, Lower pale. *c*, Stalk.

A common impurity is shelled Holcus (fig. 43). Purple Molinia (seed group 3, fig. 44) also occurs, and is easily distinguished by the dark-brown husk with purple tip, by the comparatively long stalk ending like a bone with a cleft knob, by the gaping point of the husk due to excessive narrowness of the lower pale, and by the excessive bulging of the upper pale next the stalk.

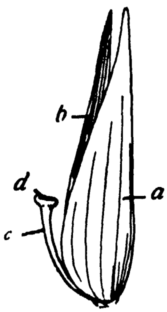


Fig. 44. — Purple Molinia Seed, side view (× 8)

a, Lower pale. *b*, Upper pale. *c*, Stalk. *d*, Bonelike apex of stalk.

Timothy.—This seed occurs either with its silvery husk or as the naked grain (shelled Timothy). The grain is almost globular; unlike a grain of wheat, there is here no flat face with a groove.

Seed Group 4.—The seed is a portion of the spikelet with an awned back or base.

Golden Oat Grass (fig. 45).—The point of the back (lower) pale is split into two hairlike points, and looks as if it had three awns instead of one. The husk of the ripe seed is very thin and coloured like gold. A common substitute is Wavy Hair Grass with a basal awn, and without a feathered stalk. There is a tuft of hair at the base of the seed, but none on the stalk.

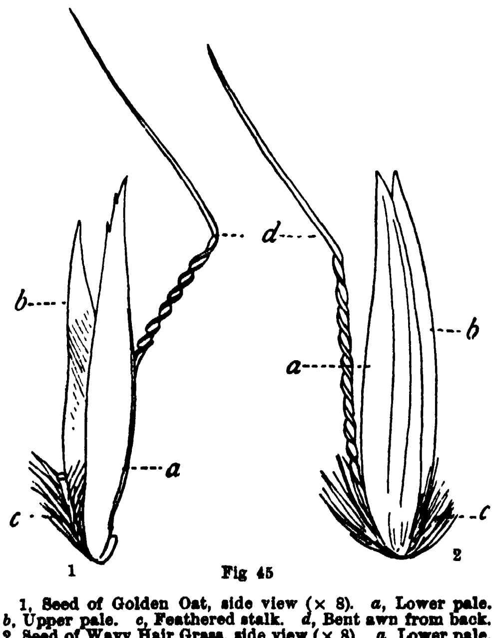


Fig 45

1, Seed of Golden Oat, side view (× 8). *a*, Lower pale. *b*, Upper pale. *c*, Feathered stalk. *d*, Bent awn from back. 2, Seed of Wavy Hair Grass, side view (× 8). *a*, Lower pale. *b*, Upper pale. *c*, Stalk. *d*, Basal awn.

Seed Group 5.—Double seeds.

French Rye Grass, or *Non-bulbous Tall Oat* (*Arrhenatherum avenaceum* var. *non-bulbosum*, fig. 38).—The seed is cylindrical, not flat. Only the upper of the two flowers contains a grain. This fertile part bears a fine, very short, straight awn. Rye Brome (seed group 2, fig. 41) is sometimes used as an adulterant. [A. N. M'A.]

Grasses, Insect Enemies of.—*Tipula oleracea* (Daddy-long-legs), *Melolontha vulgaris* (Cockchafer), *Agriotes lineatus* (Wireworm), *Charæas graminis* (Antler Moth).

Grasses, Nutritive Value of.—Many have been the attempts made to determine the relative nutritive values of different individual grasses, and also of the mixed herbage of pastures. But the question is one surrounded by a great deal of difficulty, arising not only from the differences which individual grasses may show when grown under varied conditions and on particular soils, but also mainly from a want of knowledge as to what really determines the nutritive value, that is, which the constituents are that decide this, and what is the relative importance to be attached to each. Even in the case of the ordinary feeding stuffs of the farm it is difficult to compare them in regard to their known feeding constituents, more especially when the same food may be useful not because of one of these constituents only—*e.g.* the oil, the starch, or the nitrogen—but for all of them together. Still more difficult is it to assess values in the case of grasses, when not only may the percentages of these vary at different periods of the growth, but when the very forms of combination of the constituents alter during the growth, and when, along with these changes, are introduced further considerations of mechanical nature and palatability. Certain facts have, it is well known, been established, as, for instance, that grasses are of highest nutritive value before the time of flowering has been reached, but such considerations have equally to give way, in practical agriculture, to others of economical nature, as, for example, the stage at which there will be the best return when both bulk and quality are taken into account. To cut a crop at an early stage in order to secure the highest quality may be a mistake economically, and so may it be to allow a crop to become so ripe that its good quality may be sacrificed. If this applies in the case of an individual grass, it does so the more when a mixture of grasses, each possessed of particular characteristics, goes to form the constituents of a pasture. In the cutting of grass for hay, moreover, one has also considerations of the weather to take into account, and the favourable opportunity has often to be seized, to the exclusion of whether the quality will be improved or deteriorated by further waiting.

Putting aside, however, these points, important as is their bearing, the great difficulty is to know what value to assign to the relative chemical constituents and to the amounts in which they are severally present. What is to be taken as the factor or factors indicating excellence? Is it to be the nitrogen, the carbohydrate matter, the oil, or what? Opinions on these points have varied greatly, and have undergone change from time to time. At one time it was thought that what was capable of being removed by treatment with hot water marked what was readily available, and so supplied an index to the nutritive value. At another time the respective richness of grasses in nitrogen was taken as the determining factor, while, at a later date, this view was rejected and attention given to the relative digestibility of the different constituents as ascertained by actual feeding experiments with animals.

The first work done in attempting to assess nutritive values of grasses was by Geo. Sinclair, the author of Hortus Gramineus Woburniensis, who carried out the experiments inaugurated at Woburn by John, Duke of Bedford. Sinclair's plan was to grow on small plots—4 ft. square—different varieties of grasses, and, after cutting the crop, to take equal weights of each grass and subject these—in accordance with the advice of Sir Humphry Davy—to the prolonged action of hot water. The soluble portion removed by this treatment was evaporated and weighed, being taken then as the measure of the nutritive value. Although this was the first step in putting knowledge on the subject in ordered form, it was soon recognized as being an unsatisfactory method. Way showed that by this treatment the albuminous bodies were not extracted at all; moreover, the analyses, being taken only at the time of flowering, did not represent the grass at its other stages. Way showed also that the differences between the same grass cut at two different stages were frequently greater than those between two different kinds of grass.

Subsequent to this, much work was done both in Germany and America, while, in our own country the investigations of David Wilson, jun., of Carbeth, Stirlingshire (1885), have contributed to a better knowledge of the subject, as did also the work of Martin John Sutton and others. Early in 1886 Martin John Sutton published in his book Permanent and Temporary Pastures, illustrations of the principal pasture grasses, and these were accompanied by analyses of each, by Dr. J. A. Voelcker, in which were separately stated the amounts of albuminoid and non-albuminoid nitrogen, as also those of soluble and insoluble albuminoids. Though these were, at that time, the most complete series of analyses published, there was no attempt made, except in a general way, to compare the different grasses, or to affix to them 'nutritive values' based upon the respective analyses. The following grasses, however, stood out, as the result of the comparison of analyses, as possessing high nutritive properties: *Alopecurus pratensis* (Meadow Foxtail), *Festuca ovina* (Sheep's Fescue), *Poa nemoralis* (Evergreen Meadow Grass), *Festuca heterophylla* (various-leaved Fescue), and *Poa trivialis* (Rough-stalked Meadow Grass); while *Lolium perenne* (Rye Grass), *Phleum pratense* (Timothy, or Cat's-tail), *Anthoxanthum odoratum* (Sweet Vernal), *Lolium italicum* (Italian Rye Grass), and *Dactylis glomerata* (Cocksfoot) came next in order.

Martin J. Sutton also in 1891 contributed to the Bath and West of England Journal a Paper on 'The Relative Feeding Value of Grass Cut at Different Periods of Growth', in which were recorded the weights (green and dry) of cuttings of the herbage of an old pasture at different periods ranging, for the first cutting, from June 3 to July 29; for the second cutting, from Sept. 2 to Oct. 29; a third cutting being

also taken on Oct. 29 from the earliest cut plot. The result of these trials was to show that the earliest cut plot produced in the end the greatest amount of dry matter, and the latest cut the least. Accordingly, there was a clear loss from late mowing, and it was further shown that even at its flowering stage, meadow hay had passed its best. The chemical results of the enquiry were discussed in the same paper by Dr. J. A. Voelcker, who made analyses of the several cuttings of the different plots, combining the analytical results with the actual weights of produce obtained, and setting out the different constituents contained per acre in each case. As regards the first cuttings, in the earliest cut portions (June 3) the albuminoids were in highest proportion, as were also the non-albuminoids, or amides. The albuminoids and amides then both began to decrease, and by July 29 the non-albuminoid nitrogen had disappeared altogether. In the early cut grass there was less indigestible fibre and more digestible carbohydrates than at any other period. The earliest cut grass was richest in albuminoids, in total nitrogen, in digestible carbohydrates, and in ash, while having also the least amount of indigestible fibre; accordingly, it was by far the most nutritious.

Comparing the second cuttings with the first, it was found that an early cut aftermath was as good as an early first cut, but that as the cutting was left later the grass deteriorated in quality, and more indigestible fibre was found in it.

Taking the crop as a whole, the earliest cut plots produced the greatest weight per acre in albuminoids, digestible carbohydrates, and in mineral matter, as well as in total crop, and that as the cutting was delayed so the nutritive constituents decreased in amount, the plots longest delayed giving the least weight per acre of these valuable bodies.

David Wilson, jun., made important contributions to the subject of the nutritive value of grasses in Papers contributed by him to the Highland and Agricultural Society's Journal in 1886 and 1889, as the outcome of experiments in growing individual grasses in 1885, these being continued for the next three years. Wilson not only took the produce (green and dry) of each variety of grass, as ascertained in three different cuttings, but he made analyses of the produce, and, affixing to the several constituents values, partly derived from Continental investigations and partly as modified by himself, he summed these up, having regard to the total produce, and thus made a comparison of the total value of the produce in each case. The analytical work included determinations of digestible and total albuminoids by new methods. 'Fat, wax, and chlorophyll' were estimated by extraction with carbon bisulphide, but only a portion of this was considered as representing fat, and was multiplied by 4, to bring it to terms of carbohydrates, in accordance with Continental practice. The digestible albuminoids were multiplied by 7, the indigestible by 4, and the non-albuminoid bodies by 2, to bring them to terms of carbohydrates. These different amounts were added to the carbohydrates, and the totals were then used for comparing the different grasses in respect of nutritive value, and in regard to the total value of the produce obtained in each case. While it was shown, as before, that the difference in composition between different cuttings of the same grass was much greater than that between different grasses cut at the same stage; the same general results were obtained as in Sutton's experiments just recorded. The most nutritive produce was that of the earliest cut lots, the albuminoids decreasing and the woody fibre and non-nitrogenous extractive matter increasing as the grasses advanced to maturity. The digestible albuminoids were most in extent when the grass contained most total albuminoids.

Of individual grasses, Cocksfoot, because of its high crop yield, gave the greatest total value; in nutritive value Meadow Fescue was superior to all the other grasses, but gave no autumn produce; Meadow Foxtail, too, while giving the best value in the first cutting, was inferior in later cuttings and gave but little aftermath. Sweet Vernal Grass held a good position throughout, and Golden Oat Grass proved a good late grass, while Perennial Rye Grass was the only grass that gained by a slight delay in the first cutting.

Continuation of the experiments for another three years (to 1888) showed the produce of Sweet Vernal Grass and Crested Dog's-tail to fall off considerably, while Golden Oat Grass, Meadow Grass, and Hard Fescue all increased in productiveness. Meadow Fescue, though its yield fell off slightly, remained of such nutritious quality as to leave it to be fairly considered the best grass for permanent pasture. Cocksfoot, Meadow Foxtail, and Timothy kept up their good position throughout, though Cocksfoot was found to be difficult to graze satisfactorily by sheep. Lastly, Perennial Rye Grass was found not to disappear, as has been stated in some quarters, from pastures, and to be not only nutritious, but to have furnished in pastures a greater weight of produce than when it was omitted in a seed mixture.

Such a system of valuation must, as Wilson rightly remarks, be regarded merely as a 'popular method of comparing the value of one sort of grass with another', and to be 'very open to criticism'. The relative values of the different albuminoids as compared with carbohydrates are taken largely upon assumptions, the nearest guide for which are the feeding experiments of Wolff conducted in Germany, but which have not been repeated either with the cattle or the foods of this country. Further, the item of woody fibre has not been taken into account, and yet we know that, though called generally 'indigestible', this is capable of being utilized by animals, and by different classes of stock, to varying extent. Yet again, the important point of palatability is not taken into account, and, indeed, cannot be expressed in any terms of chemical analysis. Grasses may, and do, however, contain particular ingredients which cause them to be taken more or less readily by stock, and this must constitute a great difference between them. Once more, it does not follow that

what holds good with an individual grass when growing by itself, will hold good when the same is merely an ingredient, with many others, of a pasture. Nor are all soils alike, or climatic conditions the same, and the luxuriance of a particular grass, as also its quality, may be very different in one part of the country, or on a certain soil, to what they are under other conditions. Also, a grass relished by one class of stock may not be so suited to another.

Altogether, the question of the nutritive value of grasses, though light has certainly been thrown upon it, is far from definite solution, and allows only of general conclusions being drawn. [J. A. V.]

Grasses. — Parasitic Fungi. — Many fungi are recorded on meadow and pasture grasses. Owing to them the hay crop is deteriorated and is less palatable to animals; the presence of large numbers of spores may cause catarrh and other throat troubles; sometimes poisoning results. The fungi may also spread on to cereal crops and thus bring greater loss.

EAR SMUT (Ustilago).—In many districts common on False Oat Grass, Soft Brome, &c.; during haymaking the black spores rise in clouds, and the hay is unpalatable. See 'Smut' in arts. OAT and BARLEY—PARASITIC FUNGI.

BUNT (Tilletia) sometimes occurs on grasses (see WHEAT—PARASITIC FUNGI).

SHEATH AND LEAF SMUT—Several species of Ustilagineæ (see FUNGI) occur frequently on Water Grass (Glyceria) in wet meadows, on seashore Marram Grass (Psamma), and other grasses. Death of cattle in Sweden has been traced to Water Grass smutted in this way.

POWDERY MILDEW (*Erysiphe graminis*) forms white patches on stems and leaves, generally on the lower parts of the plants. Summer sporules are formed, and winter ascus-fruits. See FUNGI, 'Ascomycetes'.

SHEATH MILDEW (*Epichloë typhina*).—This superficially resembles Powdery Mildew, but the white crust of mould is generally limited to a firm band round the sheaths; this strangles the unfolding leaves. The fungus belongs to the Ascomycetes. It is recorded as poisonous to horses in France.

ERGOT (see Ergot under heading RYE—PARASITIC FUNGI).

Treatment.—Cut the grasses before the fungus has reached the spore-forming condition, and continue this for several years. Soft Brome Grass with badly smutted ears and rusted leaves has come under our notice frequently in recent years. This grass flowers early, and must be cut before flowering. Any loss of weight by early mowing will be compensated by better quality. Where fungi occur regularly amongst grass, ploughing up and a course of arable crops is advisable. Spraying of grass land is generally regarded as impracticable. [W. G. S.]

Grasshopper.—The grasshoppers, like their near allies the Locusts, belong to the group Orthoptera; they are active insects, with a large head, prominent eyes, and a somewhat flattened body. The hind legs are long, have strong thighs, and are specially adapted for leaping. The mouth parts are very powerful. The front pair of wings, as in other orthopterous insects, are long and leathery; the hind wings are even longer, but more delicate, and folded up beneath the protective tegmina. The chirping sound made by the grasshopper is produced by rubbing the outer face of the outer wing against the face of the hind leg. The grasshoppers are not of economic importance in Britain, but in America they often do considerable damage to

Grasshopper (*Locusta viridissima*)

maize, lucerne, and other field crops. In Australia, grasshoppers are very destructive to the vegetable garden. See LOCUST. [R. H. L.]

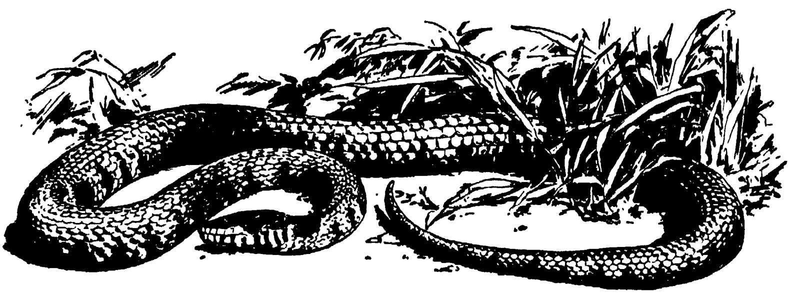
Grass Lands. See PASTURES.

Grass of Parnassus (*Parnassia palustris*) is a striking bog plant belonging to the Saxifrage order, and to that part of the order which has the ovary free within the flower (superior). It is a bald perennial herb, with a rosette of heart-shaped leaves on the ground, from the centre of which rises a simple angular stem about 1 ft. high. This air stem bears a single leaf on its side, and at its upper end a solitary white flower. This solitary leaf, unlike that of the rosette, has no petiole, and clasps the stem with its base. The white flower, about ¾ in. in diameter, is a very conspicuous object in boggy pastures from August onwards. The nectaries in the flower are five in number, and each is divided up like a hand into five segments. Botanically, these nectaries are interesting objects, representing stamens modified into nectaries. This is a very attractive plant, and if removed from its natural habitat with a ball of earth round its roots, potted, and plunged into water, it will continue to blossom for many weeks. [A. N. M'A.]

Grass Seeds. See GRASSES, PASTURES, SEEDING OF; also arts. on specific grasses — COCKSFOOT, RYE GRASS, &c.

Grass Snake (*Tropidonotus natrix*), the largest of the three British snakes, being often about a yard in length. It is widely distributed in England, especially in moist meadows near water, but does not occur in Scotland or Ireland, except as an escape. It feeds chiefly on frogs and fishes, and can swim well. It is quite harmless, and though it often hisses and makes a great fuss when caught, it never bites, having indeed no means of defence except voiding the ill-smelling contents of its cloaca and the equally offensive secretion of its cloacal glands. The usual colour is olive-grey or brown above, with black spots and narrow cross-bands; black and

white and grey below. There is often a black collar behind the head. There are nineteen rows of scales, as in the likewise harmless smooth snake (*Coronella lævis*), but the scales are keeled as in the adder, where, however, there are twenty-one rows. There are usually seven scales along the upper lip, and the third and fourth of these border the eye. Grass snakes pair in May or June, and lay about three dozen soft-shelled, inch-long, yellowish eggs in July or August, usually in a clump amid decaying vegetable matter. The young are hatched at the end of summer or in autumn; they feed for a few weeks on insects and worms before they take to small frogs. At this stage they are apt to drown if they fall into the water. The Grass Snake is easily kept in captivity, and becomes very tame. It cannot be said to be of much practical importance, but there is certainly no reason to kill it in mistake for an adder. [J. A. T.]



Grass Snake

Gratten, a provincialism signifying stubble, a stubble field; aftermath; or the first crop of grass mown after land has been topdressed with sea sand.

Gravel.—Any loose assemblage of more or less water-worn stones, whether they are siliceous, calcareous, or of any other type, is styled a gravel. But most gravels are distinctly siliceous, owing to the more ready decay of other materials. Sub-angular flints thus form gravels on the surface of the Chalk in England. Highly rounded pebbles occur in many gravels formed in streams or as beach deposits, and the mass in consequence has no stability, but always furnishes a loose surface. Sand commonly occurs as an interstitial material, and some of the siliceous glacial gravels form the worst type of land for the agriculturist. [G. A. J. C.]

Gravel Soils.—Siliceous gravels, when unmixed with finer material, produce soils which are agriculturally poor or barren, and no manurial treatment, however generous, will render them profitable. Their open texture permits of the washing away into the deeper subsoil of all the fertilizing material which would otherwise accumulate near the surface, while their small capacity for holding water and their low capillarity expose them to disastrous droughts in dry seasons. Whenever they possess even a small proportion of fine earth, such as that derived from the decay of limestone boulders, gravel soils may become clothed with a short herbage, which in time develops a more or less retentive turf, often providing valuable grazing for sheep and cattle. Such pastures may be seen on some of the gravel eskers or 'green hills' of the central plain of Ireland. Forests of conifers will, moreover, spread on very unpromising and sandy gravel soils, as may be seen in the drift-covered regions of North Germany and Finland. [T. H.]

Grazier.—A grazier generally means one who fattens off stock for the market on grass lands. He does not usually breed or rear stock, but buys in stores or moderately fat cattle, and with the aid of concentrated foodstuffs finishes them off on the grass for the butcher. Some graziers rent grass land from arable farmers generally within a moderate distance of a central market, and have little or no pasture of their own. In the winter the flying stock may consist chiefly of sheep, and in summer lambs and fattening cattle. The grazier is not now nearly so common as in past time; but whether this is due to the increased skill of the ordinary farmer in selecting store cattle which will rapidly come to maturity, or to the rise in the price of foodstuffs, or to the importation of live stock from abroad, it is difficult to say. [R. H. L.]

Grease.—The bane of the cart, stable, or breed of heavy horses is this eczematous inflammation of the true skin affecting the oil glands of the lower portions of horses' limbs, and giving rise to symptoms, in the first place, of itching and irritation, which cause the sufferer to stamp at night and rub his legs across each other, often inflicting injuries with the shod foot upon the pastern or other part of the corresponding limb. A discharge of fluid, comparable to melted lard in consistence, may be observed around the pastern and heel, and this spreads upwards as well as downwards to the heel, and emits a most offensive odour. The disease is strongly hereditary, and may occur in colts at grass before their second year is reached. Still more likely is it to come out if the young animals are yarded during winter. Constitution is gained by exposure, if properly fed, and grease is much less likely to invade the limbs when colts are wintered out-of-doors. Washing the legs is an exciting cause of grease, and the practice of letting the mud dry on and brushing out next day when dry proves the better system. The round-legged and underbred are more prone to grease than horses with flat bones and well-made carcass. There is less grease among the Shires of to-day than formerly, when the breeding industry was not conducted on scientific lines, and any sire was employed upon a broken-down mare which the owner was reluctant to shoot. Neglected grease leads to cracks and ulcerations of a per-

manent character, and to the growth of so-called grapes of a fungoid and irritating nature, and emitting a most unpleasant smell. The lighter breeds of horses are not exempt from this disease; but the heavy ones are its special victims, both from their slower circulation and hairy limbs, which conceal the early symptoms, and the disregard which is too often paid to those mentioned above as initiating the attack.

Treatment is effectual if taken in time, and palliation possible in the worst of cases, if not a practical cure. A bold dose of aloes, as a ball containing from 6 to 8 dr., is first given, and in bran mashes once or twice a week 1 oz. of nitre, 1 oz. of resin, 2 oz. of sulphur, and 4 oz. of Epsom salts. This dose for an adult Shire horse may be reduced for colts or horses of the carriage class. It has long been known that diuretic medicines keep grease in check, but it is not so generally known that Epsom salts is the most effective remedy, especially in such a combination as we have suggested. Dram doses of sulphate of copper have a good effect upon chronic cases, and such quantities may be given nightly for a week or more, and then remitted until occasion requires. No greasy applications should be used, but a lotion of 5% chloride of zinc, or sulphate of copper, zinc, and iron, will keep down the irritation and smell, and check the growth of grapes. When the latter have formed, it is the custom to burn them away with the flat shovel of the blacksmith — a tedious and painful operation, only justified by the result. A better plan is to slough off the grapes with a plaster of 1 part arsenic and 4 parts soft soap. But this needs to be used with great care to avoid injury to the heel. [H. L.]

Grease-banding of Fruit Trees.—The best method of preventing the ravages of Winter Moth, Early Moth, March Moth, and Mottled Umber Moth caterpillars is by 'grease-banding' the trees. The female moths, being wingless, have to crawl up the trunks of the trees to deposit their eggs, and are thus trapped in the grease. The grease bands are made as follows: A piece of greaseproof paper, about 8 in. wide, is tied above and below around the trunk of the tree, and then smeared with cart grease or some special compound. Various kinds of grease are on the market specially made for this purpose. If stock are kept in the orchard, the bands must be either high up the trunk or very low down, to prevent them rubbing the grease off. It is advisable to have the bands low down when possible. They should be in working order by the beginning of October (see Cheimatobia brumata), and should be kept moist until the end of March. No other insects which are harmful are caught by this method. The grease should never be applied directly *on* the bark, as it often has a very deleterious effect upon the trees. [F. V. T.]

Great Dane.—The Great Dane as he now exists may almost be regarded as a modern breed, for although he has undoubted claims to be accepted as a descendant of a very ancient variety, he has within the last thirty years been the subject of important changes of conformation. There can be no doubt that his ancestor was the Danish Dog, a breed of considerable stature which fashionable folks many years ago were pleased to have in attendance upon them when driving out, in the same style as the Dalmatian was used subsequently. The breed eventually found its way into Germany, where it was cordially received, and where doubtless it was extensively crossed with native varieties of big dogs. As a result, some years ago there were two races of tall massive-looking dogs in Germany, namely the Boarhound and the so-called Great Dane, which resembled each other in many respects, though the latter was the lighter built and more active of the two. They were, however, so much alike as to cause confusion amongst the public, and therefore, with the view of ending the uncertainty which prevailed, the leading German breeders decided to proceed so far as possible in uniting the two varieties under the common title of German Dog. There can be no doubt that the Boarhound, a heavily built, big-headed animal, suffered most by the above decision, as the elegant-looking Danish variety was the favoured breed, and its popularity has practically extinguished that of its weightier and more uncertain-tempered relative.

Great Dane

Since the above decision of the German breeders was arrived at, the support awarded

to the Great Dane in this country has very greatly increased, though its British admirers have not adopted the title of German Dog for it, preferring to adhere to the name by which the breed has always been known in England. The general appearance of the Great Dane very much resembles that of an extremely large Bull Terrier, as the breed is built upon most graceful lines, and a good specimen does not carry an ounce of lumber on any part of its frame. It is, in fact, a most active dog—in short, wonderfully so, when its proportions are considered; but unfortunately it possesses a great tendency to be weak at the joints, the result being that cowhocks, which turn inwards so that the stifles and feet turn outwards, disfigure the appearance of many otherwise good specimens, whilst crooked pasterns in front are not uncommon. Such blemishes are unquestionably caused by the weight of the body pressing heavily upon the limbs of growing puppies; and consequently attention to the latter, by which is meant good feeding and proper exercise, would probably save many a good dog from being disfigured for life. The head and muzzle of the Great Dane are long and lean, the skull being flat at the top and of fair breadth, any approach to thickness or coarseness being regarded as a fault. The jaws are very powerful, the teeth being large, and the eyes rather small for the size of the dog. They vary in colour, too, from brown, which is the usual shade, to the wall or china eye which is to be found in the 'harlequin' or pied variety, which also often possesses a spotted nose. In Germany it is the practice to crop the ears of Great Danes, but it is contrary to law to do so in this country. The neck is long and free from dewlap, the shoulders long and sloping, and the chest narrow but very deep. Straight, heavy-boned fore legs are essential to the success of a Great Dane, and the body and loins should show considerable power, the former being rather long, whilst the tail should be of fair length and carried in a slight curve, but not too high. The usual colours are fawn, blue, brindle, and pied or harlequin, and the weight of a good specimen is from 120 lb. to 130 lb. [V. S.]

Great Yellow Underwing, a large brownish-coloured moth. See TRYPHÆNA.

Green Cheese.—In days gone by, it was a pleasing incident in the dairy world, in some of the dairying districts of England, that certain dairymaids should be called upon to make a few 'green cheeses', that were chiefly wanted by dealers in cheese or by private individuals as presents to be made at the festive seasons of the year. These cheeses were not green throughout, and the colouring matter was wholly artificial, so far as its presence in the cheese was concerned. Sage and parsley are often dried green, for winter use, and it was sage chiefly that was employed in the production of green cheese. This sage was rubbed into fine particles, and well mixed into a portion of the curd whilst the latter was in a loose, granular condition. This curd was then put into other curd, of which a cheese was being formed in the press-vat, in thin layers, often in patterns, sometimes coming to the surface in designs or names of persons for whom cheeses were intended as presents. Occasionally one has seen instances of artistic skill in the colouring of these green cheeses. They are but seldom made nowadays. The term 'green cheese' is also used to denote new, immature, or unripened cheese. [J. P. S.]

Green Crops or **Root Crops** are those crops which alternate with cereal crops in the course of a rotation. The object of green cropping is to provide a supply of succulent food material for the farm stock, to permit of a thorough cleaning of the land, and to ameliorate the physical condition of the soil. The principal green crops, or fallow crops as they are also called, are turnips, potatoes, cabbages, kohl-rabi, mangel-wurzel, beans, and cabbages. Sometimes carrots, beet, and parsnips form part of the green crop. These crops are usually grown in drills, but in some of those districts which are subject to drought they may be cultivated on the flat. For further particulars see under the various headings of the crops named; also ROOT CROPS, GREEN FOOD, FALLOW, &c. [R. H. L.]

Green Fly, the collective name for the Plant-lice or Aphidæ: so called on account of their prevailing green colour. See APHIDÆ.

Green Food includes the succulent crops grown for the feeding of cattle. They are all characterized by a high water content. Their actual nutritive value varies according to their chemical composition. The following list gives the average percentage composition of a few of the principal green foods:—

Green Food.	Water.	Dry matter.	Albuminoids.	Oil.	Carbohydrates	Fibre.
Pasture grass	80·0	20·0	3·0	0·75	10·0	5·0
Clover	81·0	19·0	3·5	0·75	8·0	5·0
Vetches	84·0	16·0	3·5	0·50	6·0	5·0
Lucerne	76·0	24·0	4·5	0·75	9·0	7·0
Cabbage	85·0	15·0	2·5	0·75	7·0	2·0
Rape	86·0	14·0	2·75	0·75	6·0	3·0
Turnip	90·5	9·5	1·0	0·25	6·0	1·0
Swedes	88·5	11·5	1·5	0·25	8·0	1·5
Mangel	88·0	12·0	1·25	0·25	9·0	1·0
Carrots	87·0	13·0	1·25	0·25	9·5	1·5
Potatoes	75·0	25·0	2·0	0·25	21·0	1·0

The above analysis shows the total amount of the constituents present in the different foods. These figures should not, however, be taken as indicating the real nutritive value of the foods,

as a certain amount representing the indigestible proportion must be deducted in each case.

The chemical composition of succulent crops is variable. The principal factors causing variation are: season, manuring, soil, and variety of crop. The influence of age on the crop is well shown in the following table giving the analysis of pasture grass cut at different dates:—

Date of Cutting.	Percentage Composition.				
	Albuminoids.	Fats.	Carbohydrates.	Fibre.	Ash.
May 14th	11·5	3·2	40·8	23·0	15·3
June 9th	9·4	2·7	43·2	34·9	8·0
,, 26th	7·8	2·7	43·3	38·2	7·3

The nutritive value of grass decreases as maturity approaches. Root crops, on the other hand, increase in feeding value as maturation is reached. Green foods are indispensable for the healthy and economical feeding of farm stock. They generally form the bulky portion of food rations. Swedes and turnips are the two crops principally grown by the farmer for his supply of green food; though the other crops enumerated in the above list are not so extensively grown, they nevertheless occupy a prominent position in any scheme of rotation. [R. A. B.]

Green Gage, the name of a variety of plum supposed to be a native of Greece but long cultivated in England. There is now a section of plums known as gages, which are marked by the same characteristics of form and flavour, and by their flesh coming away clean from the stone (freestone). The best of these are Greengage, Purple Gage, and Transparent Gage. For cultivation see under PLUM. [W. W.]

Greenhouse. — The usual dictionary definition of greenhouse as an artificially heated structure chiefly covered with glass is inaccurate. As a matter of fact, entirely unheated glass-houses are extensively employed even by commercial growers, and they are capable of accomplishing a great deal. The term greenhouse is technically employed by gardeners to denote a glass-house devoted to decorative purposes and to the cultivation or display of plants that do not require a high temperature, for the most part in pots or tubs, whereas a conservatory usually contains a number of larger and permanent occupants, and in a so-called intermediate house, or a stove, a still higher temperature is maintained. Glass-houses of all descriptions are often so designed that they do not afford the plants what they most require — *i.e.* the maximum amount of light. But there has of late years been a decided improvement in the substitution of large panes of glass for small ones, and the essential matter of ventilation is now also usually better provided for. [W. W.]

Green Leap Weevil. See PHYLLOBIUS.

Green Manuring is one means adopted for enriching the soil with nitrogen and humus. The crops usually grown for this purpose are red, white, and crimson clovers; peas, vetches, lupins, &c. Among the non-leguminous crops are rye, mustard, rape, and buckwheat. The crop may either be ploughed in or fed off by cattle on the land, or the green produce carted to cattle sheds, where it is consumed and the dung returned to the soil. When the crop is ploughed in, the whole of the constituents of the crop are added to the soil; in the other case they are restored to the soil in the form of manure, having, however, suffered some loss in providing increase in the animal body, or during the making and storage of the manure. Green manuring is therefore a method of renovating and improving the fertility of a soil. Leguminous crops, through the nodules on their roots, have special power in fixing the free nitrogen of the atmosphere. On ploughing in such crops, their roots, stems, and leaves contribute a very valuable supply of combined nitrogen to the soil, along with organic matter. It is difficult to arrive at an estimate of the quantity of nitrogen added to a soil in this manner, but in the case of red clover, the stems and leaves alone would supply from 40 to 50 lb. of combined nitrogen and about 2500 lb. of organic matter per acre. The roots would supply considerably larger quantities than the leaves and stems. After ploughing in, the combined nitrogen is slowly liberated from its compounds by bacterial action, and ultimately appears as nitrate, in which form it is taken up by crops. This addition of combined nitrogen to the soil by ploughing in rapid-growing crops is one of the principal objects in green manuring, and the supply of organic matter provided is of inestimable value to soils poor or deficient in humus.

No addition of mineral matter to the soil takes place as the result of green manuring, as the crop obtains all its mineral food from the soil; unlike the nitrogen, which in the case of leguminous crops is taken from the free nitrogen of the atmosphere, and the amount added to the soil is a direct gain. The quantity of nitrogen supplied to a soil by the growth of leguminous crops in a rotation is almost sufficient to counterbalance the losses arising by the sale of nitrogen in the farm products.

Apart from the nitrogen, the large quantity of organic matter the green food supplies adds materially to the improvement of the physical properties of soils. This factor is of immense importance in the improvement of poor sandy soils.

The non-leguminous crops grown as green food have not the power possessed by leguminous crops in increasing the amount of nitrogen in soils, but their growth prevents losses of nitrates, which they take up, and which otherwise might be lost through drainage.

The following table gives the result of an experiment conducted at the West of Scotland Experiment Station, Kilmarnock, to show what effect the ploughing in of the aftermath of several green crops has upon the crops immediately following:—

Green crop ploughed in.	Yield per acre of Barley crop following.	
	Total grain.	Straw.
	lb.	cwt.
Red Clover	3440	$39\frac{1}{2}$
Lucerne	2760	$29\frac{3}{4}$
Trefoil	2680	$30\frac{3}{4}$
Italian Rye Grass ...	2680	31
No green crop ...	2480	$27\frac{3}{4}$

The grass and clover seeds were sown along with Oats in the preceding year. [R. A. B.]

Green Rosechafer, a beetle, of a bright-green colour tinged with gold, which is destructive to flowers and fruits. See CETONIA.

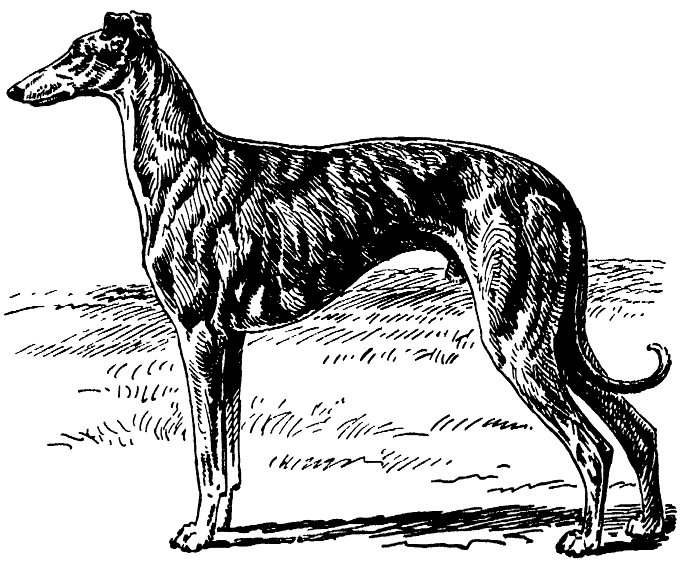
Greensand.—In marine sediments of all ages, glauconite is likely to occur, and in some sands it is so abundant as to give them a greenish tint, especially when the colouring mineral becomes streaked out by a blow from a hammer. Such 'greensands' are conspicuous in British Cretaceous deposits, those of Co. Antrim being exceptionally dark in colour. The 'Lower Greensand series' (see art. CRETACEOUS) contains many greensand strata, notably in the Hythe Beds. The Thanet Sand is also at times a greensand. Greensand is forming at the present day off shores where the decay of foraminifera leads to the deposition of glauconite (see art. GLAUCONITE) amid sand. A fine example occurs in Sydney Harbour. [G. A. J. C.]

Greenstone, a very convenient old term for the numerous varieties of altered basic igneous rocks, which have a grey-green tint, owing to the formation of chlorite from their ferromagnesian silicates. The common diorites, gabbros, aphanites, ancient augite-andesites, and so forth, in the British Isles may be generally termed greenstones. The word is practically synonymous with 'diabase' as used by Hausmann. [G. A. J. C.]

Greyfaces.—Greyfaces, or Half Longs as they are sometimes termed, are the progeny of the Cheviot when crossed with Blackface sheep. The cross, which may be made either way, is successful where good rams and ewes are used, though it is affirmed that the employment of a Blackface ram and a Cheviot ewe gives the better result. The Greyfaces form better nurses, the wool is superior to that of the Blackface, and the ewes are suitable for recrossing with Leicester rams.

Grey Heron (*Ardea cinerea*).—This long-legged wading bird with sharp elongated beak is the only species of its genus which breeds in this country, there being many 'heronries' in England, and a smaller number in Ireland and Scotland. Herons haunt the banks of inland waters, and feed chiefly on fish (especially eels), together with frogs, mice, young birds, insects, worms, and snails. They do some harm to fisheries and fish hatcheries, but are not of agricultural importance, though beneficial to a minor degree. [J. R. A. D.]

Greyhound.—The antiquity of the Greyhound has been established beyond a doubt by the fact that dogs which bear a strong resemblance to the modern representatives of the breed are depicted on some of the most ancient monuments which have been discovered in Egypt and the East. The fact, too, that Arrian, also known as the younger Xenophon, alluded in his writings to a race of dogs which hunted by sight and not by scent, proves that the peculiar faculty of the Greyhound family was recognized many centuries ago, whilst it may be added that the breed appears to have been a favoured variety amongst sportsmen of all denominations ever since.



Greyhound

If evidence of this fact were required, a reference may be made to the eulogies bestowed upon the Greyhound by Dame Juliana Berners of Sopwell Priory, in her famous Book of St. Albans, which is claimed to be the first work devoted to sporting subjects written in English. In short, it is surprising how closely the dogs of the present day conform to the old standard, the circumstance being probably due to the fact that few exhibitors at dog shows enter Grey-

hounds, the result being that this ancient breed has, fortunately for itself, so far escaped the misdirected attentions of those who introduce undesirable crosses into an old variety under the guise of improvements.

There can, however, be no ignoring the fact that the king of sports, as coursing has been styled, has suffered a good deal by the scarcity of hares in some districts; but, on the other hand, no sport has ever possessed a stancher or more loyal body of supporters. As a consequence, the small local meetings which are held attract plenty of attention, whilst the most important ones, such as the gatherings of the Border Union and those held near Liverpool, amongst which the Waterloo Cup fixture is most prominent, retain all their old hold upon the public.

A considerable number of farmers and country gentlemen, moreover, still keep a few Greyhounds, sometimes only one or two, which they train at home, and from which they derive a great deal of pleasure and healthy exercise. It is not a difficult task to train the dogs, provided that a sufficient amount of slow, healthy exercise can be provided for them every day, and proper attention can be paid to their food. No dog will put on muscle unless he gets a great deal of walking, as, though a fast gallop now and then is useful in clearing his wind, too much of that sort of thing is not good for him, and nothing can be worse than constantly slipping him at hares. If this is done, the dog will soon become cunning, and will find out that he will get his teeth into his hare with less trouble if he cuts corners, and does not keep as close to her scut as he can, and follow every turn she makes. Hence the vital importance of not letting a Greyhound which is to be used for coursing purposes see too many hares.

The question of feeding a dog which is being trained is also most important, especially as many people cannot be brought to recognize the absolute necessity that exists for only supplying him with the best quality of food. An animal which eats poor stuff may look big and well, but he is not as hard and clean inside as he should be. For general training purposes there are few things to compare with the biscuits which the owners of Spratt's Patent specially supply for Greyhounds, as these contain meat in suitable proportions, and save an immensity of time and trouble in cooking. Such things as bullocks' heads and sheep's paunches are excellent for dogs which are not in training; but when muscle has to be laid on, strength kept up, and general fitness secured, the best of flesh and the highest quality of meal and flour are not only the cheapest in the end, but they secure the most satisfactory results.

The head of the Greyhound should be long, lean, and rather narrow, the muzzle being of considerable length and great power, and the teeth of more than average strength, so that a hare can be easily seized across the loins. The nose is dark in colour and of good size, and projects a little; the eyes are small, rather close set, and very keen-looking; whilst the ears are small, and usually carried with the tips laid back so as to show the inner lining, as in the case of the rose ear of the Bulldog. When excited, however, the Greyhound usually carries them in a semi-erect position, similar to the carriage of a Collie's ears. The neck must be long, slender, and free from any superfluous lumber, and the shoulders long and very sloping. This formation is important, as, if it is absent, the dog would not be able to pick up his hare when running at full speed. To ensure the latter the chest should be narrow, and in order to allow room for the head and lungs it must be correspondingly deep and the ribs nicely rounded. The fore legs should be heavy in bone, and perfectly straight all the way down to the feet, which should be quite round and compact, showing well-developed knuckles. The body rises at the loins, which gives it a 'roached' or 'wheel' appearance; the loins are powerful but rather tucked up, and the tail, which is long and fine, is set on low. A good deal of importance attaches to the hind legs, as these are responsible for the propelling power of the dog, and therefore they should be well bent at the stifle, and possess considerable length between this joint and the hock. The colour of the Greyhound varies, as black, blue, brindle, red, fawn either whole coloured or associated with white, are all met with, and pure-white specimens are not unknown. As regards weight there is little to say, as it varies so much, but from 55 lb. to 60 lb. may be regarded as the average, though it may be added that Coomassie, who won the Waterloo Cup twice, ran at only 44 lb. [V. S.]

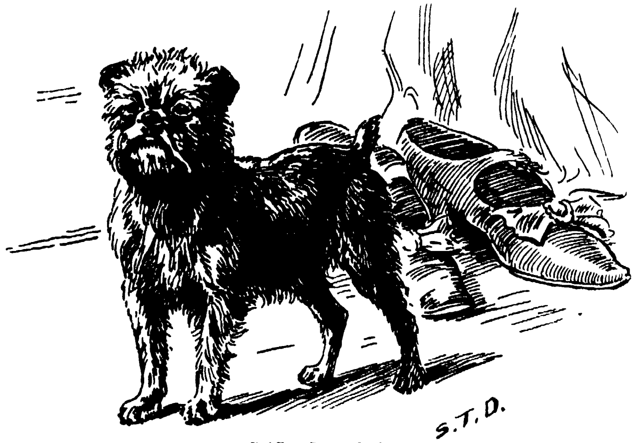
Greywacke.—This quaint old term, from the German *grauwacke*, has been used for sandstones containing mica and some clay. Fragments of slate occur in some of the rocks called greywacke, while others have an argillaceous ground, and pass into impure slates. Typical greywacke is a micaceous grit of ancient date, like those of the Scotch Silurian strata.

[G. A. J. C.]

Grieve, a Scottish term for a foreman employed by the farmer or estate manager to superintend the working of the farm. See Bailiff and Agent, Land.

Griffon Bruxellois. — This attractive-looking little dog is a toy variety pure and simple, and consequently possesses no attractions in the eyes of the sportsman. Its number of breeders, too, is rather limited, as it is practically in a very few hands; but there can be no denying the fact that the Griffon Bruxellois is a capital little indoor pet, its vivacity being great and its appearance most attractive. The curious monkey-like expression of countenance it possesses cannot fail to command attention and is regarded as one of its leading characteristics, as is likewise extreme smallness of size —its weight is only about 7 lb.—and a characteristic coat. The latter is rough and broken, not too long nor yet too short, and of a yellowish chestnut colour which is very pleasing. The eyes are dark and extremely bright, the head slightly rounded and rather large for the size of the dog, whilst the ears, which it is the custom to crop in its native Belgium, must be

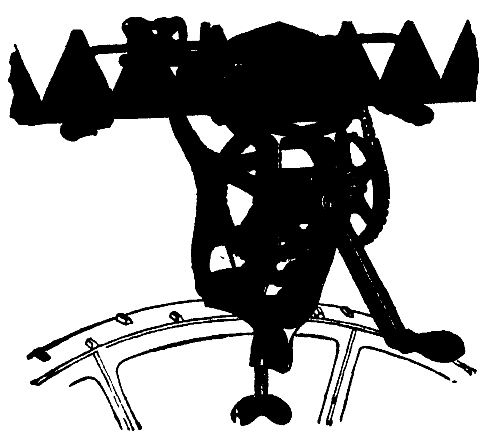
small and fine. The Griffon Bruxellois is a most active little dog, and fairly robust in constitution after the early ills of puppyhood have been surmounted; but, like many toys, it is not a very easy breed to rear unless carefully looked after and judiciously fed, for which pur-



Griffon Bruxellois

pose Spratt's malt milk, a newly established preparation, is extremely valuable. [V. S.]

Grinding and Sharpening Machine. — Grinding machines for sharpening tools are very necessary, as blunt tools make poor work. The general use of the mower and reaper has made a special call for grinders, for though files may be used they are not nearly so



Bevel-wheel Knife Grinder

good, as the bevel of the edge of the sections shortens too soon, even where care is used in handling the files. For the ordinary purposes of the farm an ordinary heavy grindstone of not too coarse grain is most serviceable, and it may be fitted with a cranked handle or with treadle, or with a pulley where there is shafting and power convenient. Grindstones may be obtained with bevelled edges for grinding mower knives, in which case it is specially desirable that the grain is not too coarse. For sharpening knife sections, emery wheels are very suitable, as they leave a good cutting edge, and sharpen rapidly, besides being very convenient to take from field to field. The bevels are cut so that they bed on to the knife at the best angle for making and keeping an edge. The emery wheels are set well free from the frames, so that other tools can be sharpened also. The speed attained by ordinary hand turning is 3500 revolutions a minute, and a steel spring regulates the pressure on the knife. A simple frame renders it easy to set them up in almost any situation. [W. J. M.]

Grinding Mills. See MILLS.

Grindstones. See GRINDING MACHINES.

Grip, the channel or gutter in a byre or cattle shed for the removal of urine and solid excrement. The forms *Greep* and *Groop* are used in same sense. Shallow artificial dykes and water courses, especially on grass land, are called grips or drifts in many districts. See GUTTER.

Gripes, an acute intestinal pain which frequently affects horses. See COLIC.

Grist Mills.—Grist mills are used to grind, crack, or grittle corn for consumption on the farm by live stock, and sometimes to produce flour for the farmer's consumption. Grist is often ground by country millers with wind- or water-driven mills as a branch of their ordinary business; briefly, gristing is grinding corn not intended for sale. The improvement in small mills suitable for the farm has taken most of the grist from millers, as farmers find it more profitable to grind it at home, and save cost of hauling, and possibly some loss in weight, or by the more unscrupulous millers a substitution of meal from unsound grain in the place of the sound sent to be ground. The farmer's grist mill should be capable of grinding to fine flour, and any larger intermediate size up to cracking beans, as all these are required on a farm where various kinds of live stock are kept. Stone mills have largely given way to other kinds, and disk grinders are the most popular, though good work is done with those with conical steel drums working in concaves. See also MILLS. [W. J. M.]

Grogginess.—A short and stilted action which is not recognized as actual lameness; or merely stiffness, impeding the action and reducing the mobility of the animal, is called grogginess; but the word 'groggy' among horsemen often means the existence of navicular disease, and the inference is that a horse which is merely groggy will warm up with exercise and throw off the stiffness and get into his stride when the joint oil flows from exertion. As the trouble is chronic and likely to increase, and is now well known to be hereditary, such animals should be avoided. [H. L.]

Grooming.—The greatest wellbeing and

efficiency is obtained in stabled animals by brushing, straw-wisping, and other means usually adopted of removing the daily accumulations of dandruff, and thereby obtaining a full action of the skin, a glossy coat, and the casting off of waste material during exercise or labour. Grooming includes the care of the feet as well as the skin, the combing of mane and tail, and sponging of the anus and perineum. The feet should be picked out every morning to avoid thrush, and the groom's duty is to test the security of each shoe when so engaged. Cows should be groomed in the byre, and fattening beasts thrive all the better for such attention. [H. L.]

Ground Beetles, a family of beetles, nocturnal in habits and very active in disposition. They are useful in destroying large numbers of insectivorous pests. See CARABIDÆ.

Ground Game Act. See GAME LAWS.

Ground Ivy (*Nepeta Glechoma*, Benth.) is a common perennial herb on hedge banks and waste ground, belonging to the nat. ord. Labiatæ. The stem is weak and elongated; it trails along the surface of the ground, rooting and branching as it goes. The stalked leaf has a kidney-shaped blade, about 1 in. broad, with rounded teeth on the margin (crenate). The bright-blue flowers appear in early spring, and are grouped in threes in the axils of the leaves. The blue corolla is about 1 in. long, and bears four stamens, with the anthers conniving to form a cross. It is a bitter, aromatic plant, formerly used like hops in beermaking, still occasionally gathered by country people, and when dried made into tea. [A. N. M'A.]

Ground-nut Cake.—Ground-nut, Earth-nut, Monkey-nut, or Pea-nut is the fruit of *Arachis hypogæa*, a leguminous plant which has the remarkable property of bearing its fruits underground, the stalk which carries the ovary or pod becoming elongated, curving downwards, and forcing its way into the earth, where the seeds are ripened. It is generally held to be a native of Brazil, but is also stated to be indigenous to Africa. It is valuable mainly for its oil, and is largely imported from West Africa, India, and China. In India it is grown extensively in the Bombay and Madras Presidencies, and there is a considerable export trade from Bombay and also from Pondicherry (Madras). Marseilles is the principal port in Europe to which the nut comes, and here it is ground in mills and the oil pressed out. The oil is largely used as a substitute for olive oil, and the refuse left is employed as a cattle-food and sometimes as manure. In India the nut is often pressed locally, either by steam oil mills or in the native pestle-and-mortar mills, the cake from the latter being the more highly prized because of its containing the more oil.

Earth-nut cake may be of two kinds: either the whole or undecorticated seed-pod being ground and pressed, or the outer husk may be first removed and 'decorticated' cake be obtained. The latter is the form in which the cake usually comes to this country. As such, it is, as the accompanying analyses show, a highly concentrated and nitrogenous food, approaching most nearly in composition to decorticated cotton cake. The percentage of oil varies from 7 or 8 per cent to 12 or even 15 per cent, according to the amount of pressure employed, while the albuminoids range from 40 to 50 per cent. In the decorticated cake the woody fibre does not exceed 5 per cent, but in the undecorticated cake it may be from 18 to 20 per cent.

AVERAGE ANALYSES OF EARTH-NUT CAKE

	Decorticated. Per cent.	Undecorticated. Per cent.
Moisture	10·43	11·60
Oil	8·17	7·17
[1] Albuminous compounds	48·32	28·50
Starch, digestible fibre, &c.	22·99	28·06
Woody fibre	4·67	18·97
Mineral matter (ash)	5·42	5·70
	100·00	100·00
[1] Containing nitrogen	7·73	4·56

According to Warington, the decorticated cake contains 1·9 per cent of its nitrogenous matters as amides. The albuminoid ratio of the decorticated cake is 1 : 0·83, of the undecorticated, 1 : 1·6. In 1000 parts of the decorticated cake there are—

76·2 parts of nitrogen,
20 ,, phosphoric acid,
and 15 ,, potash;

so that, in manurial value, the cake stands very high, and may fairly be classed along with decorticated cotton cake. In Germany, France, and Belgium, earth-nut cake is extensively used for cattle-feeding, but in this country its use is by no means general. It is, however, imported to some extent, either by itself or in a mixed cake composed of earth-nut and safflower (kurdee). Earth-nut cake also often forms an ingredient of compound feeding cakes. The not unfrequent occurrence of castor-oil bean in deliveries of earth-nut cake to this country, due either to the shipment of earth-nut and castor-bean simultaneously, or to want of care at the mills (where these are probably used for grinding the two kinds of seed consecutively), constitutes a difficulty as regards the use of the cake, and calls for constant attention that this poisonous material be not present. It is also apt at times to contain an excessive amount of sand and earthy matters.

As a feeding material earth-nut cake might very well take the place of decorticated cotton cake, and feeding experiments conducted with it on fattening bullocks at the Woburn Experimental Farm (see Journal of the Royal Agricultural Society of England, third series, vol. iii, 1892, p. 727) showed that it could replace beans in a mixed diet and give as satisfactory results. In India it is extensively used as a feeding material, and to some extent as a manure for certain of the higher-priced crops. [J. A. V.]

Groundsel (*Senecio vulgaris*) is a common and well-known annual Composite weed of gardens and rich waste land, in flower all the year round. The stem, which is succulent and about 1 ft. high, bears sessile pinnately lobed and

toothed leaves. At its end are the characteristic cylindrical heads of yellow flowers, each about ½ in. long; there are no ray florets, as in the other species of this genus. When the head of flowers is ripe it becomes cone-shaped, and bears a cluster of dry, silky, and ribbed fruits crowned with a tuft of long white hairs (pappus) to secure distribution by wind over a wide area. To exterminate Groundsel, the plants should be pulled or uprooted before the flowering stage is reached, in order to prevent fruit and seed formation. The plant in fruit is often given to canaries. See WEEDS, ERADICATION OF. [A. N. M'A.]

Grouse, Red (order, Carinatæ; sub-order, Galliformes; family, Tetraonidæ).—The Red Grouse (*Lagopus scoticus*) enjoys the distinction of being the only bird exclusively indigenous to the United Kingdom,[1] although there can be no reasonable doubt that it formed originally a single species with the Willow Grouse (*Lagopus albus*), which inhabits sub-Arctic regions in all three northern continents. No difference can be detected between Red Grouse and Willow Grouse in their anatomy, eggs, or voice; but the British bird is the only member of the genus Lagopus which does not turn white in winter, and cannot exist except on heath-clad moors, whereas the Willow Grouse haunts thickets and woods.

Red Grouse are found in all suitable districts, as far south as Monmouthshire and as far north as the Orkneys, Yorkshire forming the limit of their range on the east, and Galway and Mayo on the west. Efforts to establish them on the heathlands of southern England have not been successful, but it is reported that they have been naturalized lately in Germany, and so long ago as 1868 near Gottenburg in Sweden. Heather is indispensable to their existence, the young shoots and diminutive seeds of that plant forming the staple diet of grouse; but something besides heather is necessary, though it has not been ascertained what that is.

The plumage of the Red Grouse is rufous in general tone, but varies much between individuals of the same sex. The head and neck of the cock is generally rich reddish-brown, the back, wing, and tail coverts being of the same tint, more or less barred and freckled with black; quill feathers of the wing dark sooty-brown, the outer feathers of the tail of the same colour, the central ones chestnut marked with black. The breast feathers are darker than those of the back, nearly black, more or less tipped with white; sides and flanks chestnut tipped with white; legs and feet feathered with greyish-white down to the roots of the dark horn-coloured claws. The beak is black, the iris hazel; over the eye is a crescent-shaped patch of naked skin, vivid scarlet, rising into a kind of comb in spring. The total length of the bird varies from 15 to 17 in. The hen bird is rather smaller than the cock, the scheme of colouring being similar but paler, and in both sexes, especially the female, the chestnut tints sometimes tend to yellow. The average weight of an adult cock grouse may be put at 19 oz.

Grouse pair early in spring, and in April the hen lays from eight to fifteen eggs of a pale-buff tint thickly blotched and spotted with very dark, warm brown, making no regular nest, but scraping a slight depression among the heather. She is an admirable mother, and generally succeeds in rearing her brood, even at an altitude of 1200 or 2000 ft., through weather which would be fatal to less hardy chicks. It is indeed a marvel how sustenance can be found for these birds on the bleak wastes where spring lags long and snow lies late; but, except when the moors are devastated by the mysterious disease which forms at present the subject of enquiry by a committee recently appointed by the Board of Agriculture and Fisheries, grouse are almost invariably found to be well nourished, their flesh being more highly esteemed than that of any other game bird. In autumn the birds on moors within easy reach of arable land vary their fare by collecting upon the corn stooks, and this is the only season when the farmer suffers any injury from Red Grouse. That injury is certainly considerable when the harvest is protracted owing to bad weather.

Professor Newton has observed that the economic importance of Red Grouse 'is perhaps greater than that of any other wild bird in the world'; and this will appear no exaggeration when the enormous rents paid for grouse moors, the great outlay in travelling, wages, and equipment, and the vast numbers of grouse sent to market, are taken into consideration. The shooting season opens on 12th August, the most important day in the shooter's calendar, and closes on 10th December.

Naturalists have often drawn attention to the greater wariness of most birds towards the southern limit of their distribution; but nobody has explained satisfactorily why grouse, for instance, should avoid the presence of man on the wide moors of Yorkshire and Derbyshire with far greater nervousness than they do in Caithness and Sutherland. This fact has been the cause of a widespread revolution in the method of grouse shooting. A hundred years ago the orthodox plan was to employ pointers or setters to find the game; but fifty years later Yorkshire grouse had become so wild that it was hopeless to attempt to walk within gunshot. Therefore it became the practice, instead of sending the shooters against the game, to send the game against the shooters. Driving grouse over the guns concealed in butts has now become universal on English moors, and has extended over a great part of Scotland, but in the extreme north of the Highlands it cannot be practised, because the birds lie too close, and the old fashion of shooting over dogs is still in vogue.

Driving grouse, which was bitterly denounced at first by the old school as an unsportsmanlike device, has had one most unexpected result. It has caused an immense increase in the number of grouse on those moors where it is the only

[1] The late Mr Seebohm claimed a similar position for the St Kilda wren, which differs in colour from the common wren of the rest of Europe. He entitled it *Troglodytes hirtensis*, but it is doubtful whether this bird can be regarded as more than a sub-species or permanent variety.

method employed. A single illustration of this will suffice. It is recorded in Daniell's Rural Sports that towards the close of the 18th century Lord Strathmore backed his gamekeeper to shoot 40 brace of grouse on 12th August upon his Wemmergill moor in Yorkshire, and that he won the bet with a bag of 43 brace. The Rev. Mr. Daniell was scandalized by the slaughter, 'which by a sportsman it must be hoped never will be repeated'. What would he say of the recent proceedings on the very same ground, about 12,000 ac. in extent, yielding an average of 6000 grouse each season, 2053 grouse having been shot here by eight guns on August 21, 1889. The heaviest bag in a single day was shot by nine guns in six drives on Mr. Rimington Wilson's Broomhead moor, near Sheffield, 30th August, 1893, and consisted of 2648 grouse. Two days later, the same party shot 1603 grouse on the same ground. But all performances in this line pale before that of Lord Walsingham, who, on 30th August, 1888, shot 1036 grouse *to his own gun*; 34 being picked up dead next day raised the total to 1070. His lordship calculated that he killed at the rate of 2½ grouse per minute during the time actually occupied in shooting in the twenty drives. See art. GROUSE DRIVING. [H. M.]

Grouse Disease.—It is unusual for wild animals to suffer from disease. Though most of them have their parasites, these are not usually the cause of death. In the case of the grouse, however, a very fatal disease occasionally occurs, and has disastrous results. It is probable that this is due to artificial conditions brought about by the 'preserving' of the grouse, and that the same artificiality is the reason why worms and other parasites found in the grouse are often fatal. Dr A. E. Shipley, in his Interim Report on the Parasites of Grouse (1908), notes that the expression '*the* grouse disease' is a misleading one. 'What is usually meant by *the* disease is a somewhat sudden and very virulent epizootic which sweeps through a district, and in a very short time carries off a very large percentage of birds. Such a disease was investigated by Dr. Klein some twenty years ago, and I suggest that this disease, if it be a specific disease, be called Klein's Disease of the Grouse. Since the present Committee has been sitting, there seems to have been no outbreak of Klein's disease, but we have received innumerable grouse said by the gamekeepers and moor-owners to be affected with or killed by *the* disease, which further investigation has shown to have been done to death by worms. The symptoms of *the* grouse disease are not readily apparent, especially to the unclinical eye.'

The virulent disease is said to have been noticed first in the first quarter of the 19th century, it has recurred repeatedly, and there are many theories about it. As it seems to us, the most plausible theory is that which was forcibly stated by John Colquhoun, the well-known author of The Moor and the Loch, namely, that the disease is indirectly due to over-preservation—interference with natural selection by destroying birds of prey. If the natural enemies of the grouse—which used to kill off the weaker members—are persistently eliminated, then there is likely to be deterioration in the stamina of the grouse race. An opportunity is afforded for some micro-organism, resisted by vigorous birds, to run riot. This view is corroborated, we think, by the fact that, apart from the virulent disease, so many grouse fall victims to worms, which, if they were not unnaturally weakened, they should be quite able to stomach. Tapeworms and other intestinal worms are very common in wild birds, and in most cases they seem to do very little harm.

In 1887 Professor F. Jeffrey Bell studied a number of grouse from infected moors, and came to the conclusion that the tapeworms found in the gut had nothing to do with the death of the birds, and that the Nematode, *Strongylus pergracilis*, also abundant in grouse, must also be acquitted. The disease may occur apparently without these parasite worms being present. (Report of the British Association for 1887, p. 770.)

In Dr. A. E. Shipley's Interim Report on the Parasites of Grouse (1908) the following are discussed: (1) Ectoparasites — two bird-lice (*Goniodes tetraonis* and *Nirmus cameratus*), the former very abundant on pining birds; the Grouse Fly (*Ornithomyia lagopodis*); two fleas; the Common Dog Tick (*Ixodes ricinus*); and the Flour Mite. (2) Endoparasites—three tapeworms, whose first hosts are unknown (*Davainea calva*, *D. cesticillus*, and *Hymenolepis microps*); five Nematodes, *Trichostrongylus pergracilis* (sometimes causing serious lesions), the 'Gapes' Worm (*Syngamus trachealis*), *Trichosoma longicolle*, *Heterakis papillosa*, and a microscopic form found by Dr. Sambon in the blood; two Protozoa, an amœboid form (in freshly deposited droppings) and one of the Hæmosporidia (*Leucocytozoon lovati*), found by Drs. Seligmann and Sambon in the blood. Some of these parasites may be associated with the death of the grouse, but there is nothing to indicate that they do much more than give the deathblow to enfeebled constitution, and there is nothing to indicate that they are connected with Klein's disease of the grouse, which requires re-investigation. [J. A. T.]

Grouse Driving.—The practice of driving grouse, instead of finding them with dogs and walking up to the point, has become universal on English moors, and is now commonly adopted in Scotland wherever the ground is not too steep or the birds lie too close. It had its origin about the middle of the 19th century, when the increasing wildness of the game, corresponding to the increasing number of shooters, rendered approach in the old manner impracticable. The Duke of Rutland quotes from the game book of an English moor the earliest mention of grouse driving as follows: '*September* 11*th*, 1849.—On this day the birds were unmanageable, and at 3 o'clock we took station by a wall and killed a few birds out of packs which were driven past.' The system soon became established on the moors of Yorkshire and Derbyshire, where grouse, being somewhat earlier hatched than farther north, are also wilder and stronger on the wing at the commencement of the shooting season.

The introduction of breechloading guns gave it a marked stimulus, for in this mode of shooting the birds fly over the guns in large packs, and rapid loading is necessary if much execution is to be done. Sportsmen who have once experienced the excitement of shooting driven birds never revert willingly to the earlier method. It is difficult to explain why it should be so, for the willing co-operation of well-trained, well-bred dogs is one of the most ancient, as it is one of the most charming, features in field sport. Moreover, deer stalking is far more highly esteemed as a sport than deer driving; but there is no doubt that the skilled marksman enjoys a better opportunity for the exercise of his craft when birds are brought to him in full flight than when they have to get on the wing before him.

The bags made in grouse driving are immensely larger than those obtained by any other method of shooting, whence a serious depletion of stock might be apprehended were this system of shooting to be maintained for several successive seasons. The unexpected, but well-established, result has been that on ground which is systematically driven, to the exclusion of every other mode of shooting, the stock of birds is increased in a very remarkable manner. It was by this treatment that the Wemmergill moors were brought to such a state of fecundity as to yield 17,064 grouse during the season of 1872, the adjoining moor of High Force giving 15,484 grouse in nineteen days' shooting during the same season. On the Broomhead moor, near Sheffield, on 30th August, 1893, nine guns killed 2648 grouse. The largest number ever killed by a single gun in a day is 1070 grouse, by Lord Walsingham in 1888.

The increase of stock consequent upon driving is commonly explained as the result of a larger percentage of old birds killed in driving as compared with 'dogging' or walking in line; but it does not appear that any attempt has been made to support this theory by an analysis of bags made under the respective systems of shooting. Owners and tenants of moors should never be tempted into the mischievous practice of shooting over dogs early in the season, and resorting to driving later when the birds get wilder. This is to burn the candle at both ends, with such ill consequences as might be expected.

In preparing a moor for driving, the usual lines of the birds' flight must be carefully studied, across which a range of butts must be erected for the accommodation of the guns. Each butt must be large enough to hold a shooter, two loaders, and a dog, and may be constructed either with turf walls or planking, with a drain cut round to keep the floor reasonably dry. It is important that the butts should be exactly in line, so that each shooter may be accurately aware of the 'danger point' to his right and left. About fifty yards is the approved distance between butt and butt, and this proximity of the guns to each other makes it obvious that while every man may shoot freely to front and rear, he must on no account fire to his flanks. The novice, especially, must avoid the habit of following a bird with his gun, which has often led to serious accidents.

The number of butts, and the consequent space covered by them, will vary with the nature of the ground; in arranging them the qualities of the head keeper as a strategist will be made manifest. In bringing the birds over the guns he is put to the test as a tactician. He will bring into the field about twenty men, in addition to his own staff of keepers. These will probably be divided into two parties, in order that one party may be driving while the other is moving into position for the next drive. Every man will carry a white flag, and slightly in advance of each end of the line of drivers will be a 'flanker', carefully chosen for his knowledge of the ground and the flight of the birds. His duty is to keep the line properly extended to his flank, and to head back birds breaking away to the side. The birds should be driven down wind when feasible. If the wind is strong across the line of flight, the leeward flank of drivers should be kept somewhat in advance of the other.

The difficulties of driving a Scottish moor are, as a rule, greater than on an English one, owing to the generally steeper and more broken ground. In Caithness and Sutherland grouse are never wild enough for good driving, lying close in the heather till the beaters pass over them; therefore in these counties shooting is still commonly done over dogs. But where driving is practicable, and has been scientifically carried out, similar results have followed upon Scottish moors to those experienced in the south. Upwards of 500 brace in a day have been killed driving at Moy in Inverness-shire. But it is only on a few large estates that the new method has had a fair trial; in too many districts the moors are unfairly taxed by being 'dogged' first and then driven. [H. M.]

Grouse Fly. See ORNITHOMYIA.

Grove is a term ordinarily applied to any large group of trees, and especially to those of an ornamental character, or to those surrounding shrines and sacred edifices. From time immemorial such groves have been formed in every part of the world, and are often to be found around temples as the sole tree-growth on bare hill-slopes in the Himalayas and in China. But as regards British forestry the terms 'grove' and 'groving' have special technical meanings relating to the conversion of simple coppices or of copsewoods with standards into highwoods. The best means of transformation is to select at the last time of clearing the underwood as many good seed-grown saplings (or strong suckers and the best-grown stool-shoots) as can be found standing about 18 to 20 ft. apart. These are then left as permanent stores to grow up, and in course of time they form a grove of trees of a highwood type, though usually less regular and less even-aged than plantations or natural regenerations; and this operation is called 'groving', a term in common use in Worcestershire. When the last clearance of the underwood takes place, a favourable opportunity is given of interplanting stout Oak, Ash, or Larch transplants likely to add to the

future returns from the wood. This method appears to have been largely adopted with Larch in many of the Irish coppice woods about 1850 to 1860, and with very profitable ultimate results. [J. N.]

Growth.—That living creatures are able to increase the volume of their living material at the expense of quite different material used as food, is one of the fundamental facts—and mysteries—of life. The grass grows at the expense of air, water, and salts in the soil; the foal grows at the expense of the grass. This is very different from the so-called growth of a crystal, which can only increase at the expense of a solution of material like its own. There are some general facts in regard to growth which seem to have obvious practical corollaries. (1) Living implies expenditure of energy, there is ceaseless disruption of material; this is compensated for by nutrition and constructive chemical changes; when there is a surplus after due reparation has been made, then growth is possible. It follows that excessive expenditure of energy in external work will check growth; it follows also that during a growing period the organism should not be worked hard. (2) In most animals—fishes are well-known exceptions—there is a definite limit of growth. A certain optimum size is reached, approximately constant for the species, beyond which growth is unprofitable or dangerous. Giant forms are notably unstable and shortlived. This limit of growth has doubtless been fixed by natural selection, which punctuates the fundamental processes of life, but behind this there is the physiological consideration pointed out by Herbert Spencer and others, that in regularly shaped growing bodies increase of volume tends to outrun increase of surface. In breeding for bulk this has to be borne in mind, there are fundamental proportions of ancient origin which cannot be tampered with without risk. (3) The limit of growth is usually associated with the onset of reproduction, and the antithesis between growth and multiplication, between nutrition and reproduction, is of great importance. A check to nutrition (as in root-pruning a fruit tree) may induce reproduction or improve the reproductive capacity; reversely, the removal of the reproductive organs may increase the 'vegetative' development of the general body. (4) In his elaborate discussion of growth, Herbert Spencer sought to show that growth varies (other things equal)—(*a*) directly as nutrition; (*b*) directly as the surplus of nutrition over expenditure; (*c*) directly as the rate at which this surplus increases or decreases; (*d*) directly (in organisms of large expenditure) as the initial bulk; and (*e*) directly as the degree of organization, — the whole series of variables being in relation to the doctrines of the persistence of matter and conservation of energy. This kind of analysis is doubtless valuable, but what is most needed at present is an extensive series of measurements of growth with enquiry into the conditions in different cases. Thus the idea of a fundamental opposition between nutrition and reproduction, which Spencer emphasized (and rightly as it seems to us), requires careful adjustment to observed facts. Minot has shown that young female guinea pigs carrying young grow almost as much as their non-pregnant contemporaries. 'Gestation', he says, 'does not represent a tax upon the parent but a stimulus—it does not impede growth, but on the contrary favours it.' (5) There is a certain rhythm in growth, but little is known about it. In guinea pigs there is a steady increase in weight during gestation; immediately after birth there is a loss in weight, more marked in the males; the females begin quickly to gain and obscure the initial loss; after the post-natal retardation, the increments of growth increase from the second to the fifth day; from this time onwards they decrease, very rapidly at first, and then more slowly. (6) It has been shown experimentally that growth may be accelerated or retarded, and in some cases affected as to character, by external factors—*e.g.* the quantity and quality of the food; the presence or absence of certain stimulant substances such as lecithin; the temperature, which affects the formation of nuclear material, and thus affects the rate of cell division, on which growth largely depends. [J. A. T.]

Grub.—The term 'grub' is somewhat loosely used to denote the larval stage of those groups of insects which are characterized by complete metamorphosis. Some zoologists only apply it to the larvæ of weevils and certain Hymenoptera (such as wasp grubs). But the grubs of the farmer which are so injurious to the early stages of the cereal crop are the larvæ of *Tipula oleracea* and *Tipula paludosa*, both of which are commonly called the Daddy-long-legs. These footless grubs are brown and wrinkled in appearance, and provided with a very tough integument, hence their name 'leather-jackets'. The roots of practically all crops may be attacked by them, but they are especially destructive to young cereals. No effective remedy has yet been discovered for the eradication of these pests. Their presence in the soil is not commonly suspected until their ravages are apparent, when it is too late to adopt any combative measures. Where their presence is suspected, a good dressing of gas lime may help to minimize their numbers considerably. The application of salt is useless. Rolling with a Cambridge roller, so often advocated, is ineffective, except when carried out in the autumn on the grass land. The mature grub, on account of its tough skin, is little affected by a heavy pressure, but the eggs, which are usually deposited by the female fly on the grass, may be crushed by a heavy rolling in autumn. The natural habitat of the fly is damp and marshy land. Hence thorough drainage is to be recommended. A moist season is particularly favourable to the development and increase of these pests, and hence an attack of the grub should be suspected in the following spring. Various preparations are now put on the market which are said to be effective in destroying the grub, but their efficacy has yet to be established. See also TIPULIDÆ. [J. J. F. X. K.]

Grubber.—Grubbers are employed to break up land, sometimes when unbroken by the plough and sometimes when already broken up, but they do not systematically invert it as a plough

does. A grubber is a cultivator, but the term is so loosely applied that it cannot be said that any particular type of cultivator is implied, because though the term is commonly used in many districts, in others it is rarely used; and where it is now used it is applied to any land stirrer used for deep cultivation. Originally the term had a narrower application, and was more particularly applied to implements which were provided with a body carrying a stout point or snout, which grubbed up the soil much as a pig does. The extensive development of cultivators and their general distribution have broken down local nomenclature, and the term 'grubber' is merely one of the names applied to cultivating implements which include cultivators, scufflers, scarifiers, shims, drags, and single-row horse-hoes. The rigid body with stout snout which was associated with the grubber has been found unnecessary, as land is now better broken up by the sickle-tine cultivator, which will face the hardest work and is much lighter in draught. [W. J. M.]

Grubbing.—Grubbing is performed with the larger grubbers to break up land not ploughed since it was cropped, and as such is suitable to autumn cultivation and stubble cleaning, in which case broodshares are useful where the ground is not too hard to admit them. On turnip land fed off by sheep, especially on inclines, it is a good practice to break up the ground so that the droppings will not be washed down the hill in the event of rain falling; it is best to work horizontally or the tine-marks may form channels to conduct the flow downwards. Grubbing is satisfactorily performed on land laid up in ridges and carrying roots or potatoes, as deep stirring can be effected, preventing the loss of capillary moisture, which, taking place so low down, is apt to rob the roots of necessary moisture; and further, the deeper tillage increases the root action. [W. J. M.]

Gruel.—A custom now obtains of giving oatmeal in water to horses on the road, and this mixture has acquired the name of 'gruel' by those seeking such simple refreshment for tired hunters without waiting; but in the stable the word has quite another meaning. The following recipe is that of a famous trainer (John Stewart): 'One gallon of good gruel may be made from a pound of meal, which should be thrown into cold water, set on the fire, and stirred till boiling, and afterwards permitted to simmer over a gentle fire till the water is quite thick'. [H. L.]

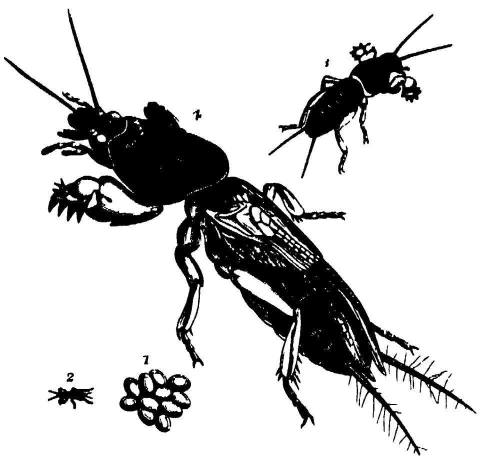
Grunting.—This may be an expression of lazy satisfaction in the pig, of fear in the horse, or of pain in any animal, and its value in diagnosis will vary accordingly. Much importance attaches to it in the horse, and in the circumscribed area of the showyard it is a rough-and-ready test of soundness of wind. Threatening a horse with a stick will often elicit a grunt which indicates a roarer or whistler, but is far from an infallible test (see ROARING and WHISTLING). When cattle grunt or gruff, there is always something wrong with them, and the matter should receive immediate attention. It is characteristic of fardelbound or impaction of the omasum when at the end of each expiration a grunt is heard, and is indeed the only marked symptom in some cases. Tuberculous animals when recumbent are often heard to grunt, but to the accustomed ear it conveys, not easy satisfaction after a full meal, but a sense of discomfort, if not of pain, sufficient to convert the grunt into a groan. [H. L.]

Gruyère Cheese.—The appellation Gruyère is really only a local one, denoting the district where, in the Canton of Friburg, a quantity of this cheese is made. The true name, used generally in Switzerland, is Guementhaler. The morning's milk is heated up to 105° or 110° F., and, where the best class of cheese is being made, cream from the previous evening's milk is added to the heated milk, and thoroughly stirred in order to effect an amalgamation, which is promoted by high temperature. The cool evening milk, which has been skimmed, is then added to the heated mass of milk and cream, to be reunited to its own cream after what would appear to have been an unnecessary separation, and the whole thing is, if necessary, warmed up to a temperature of about 95° F., when it is renneted, and coagulation is completed in, approximately, half an hour. The curd in the whey is then manipulated in a manner not unusual in other methods, save that it is gradually heated up to about 135° F., until the curd has acquired the firmness and elasticity which are considered desirable. It is shortly afterwards gathered into a cloth and put under press in a hoop.

Gruyère cheese retains much of its toughness during the ripening period and when that period is ended. Its most remarkable feature is the number of 'eye-holes' which are distributed throughout the cheese, each of them containing a drop of sweetish, yellowish liquid. This cheese is thought highly of in many countries by those who have acquired a taste for it. [J. P. S.]

Gryllotalpa vulgaris (the Mole Cricket) is a large and singular animal, which has been thus named from its burrowing under ground. Mole crickets commit serious depredations in some parts, in the cornfields and market gardens, by feeding upon the roots, and thus destroying corn, grass, potatoes, pease, beans, &c.; indeed, they seem to be omnivorous, for they will eat raw meat, live upon caterpillars and worms, attack one another, and the mother will even destroy her young. In June, the female moulds an oval cell, ½ ft. below the surface of the earth, about 2 in. long and 1 deep, with a curved burrow, as an outlet, at one end; in this she deposits two or three hundred shining, yellowish-brown, oval eggs (fig. 1). As soon as the young hatch (fig. 2), in July or August, they run about like little black ants, and begin to feed on the tender roots. As they grow (fig. 3), they cast their skins, and bury themselves, sometimes 2 ft. deep, in the winter; in the spring they become pupæ, which are distinguished by flaps on the back, and they are then about 2 in. long. When they again moult, they attain their perfect state and full stature, and are then able to fly as well as to leap

(fig. 4). The mole cricket is brown and velvety, the conical head is furnished with four jointed feelers, two strong jaws, two lateral eyes, and two minute ones between them, as well as a pair of slender jointed antennæ; the trunk is like a lobster's, furnished with a pair of most powerful feet, with strong broad claws, adapted to burrowing; the body is soft and large, with two ratlike hairy tails at the extremity, and



Gryllotalpa vulgaris (Mole Cricket)

1, Eggs; 2, newly hatched insect; 3, insect further developed; 4, insect full grown.

four strong legs are attached to the thorax; on the back are folded, like fans, two transparent reticulated wings, expanding about 3 in., protected at the base by two parchment-like flaps, the fibres of which vary in the sexes. Mole crickets may be trapped by sinking pots in the earth baited with meat. They may also be killed in the ground by injecting bisulphide of carbon. [J. C.] [F. V. T.]

Gryllus domesticus (House Cricket).—The cricket is sometimes a great nuisance in

House Cricket (*Gryllus domesticus*)

the kitchen and bakehouse, hiding by day and prowling about at night to attack the dough, bread, and many other articles of diet which are suited to its taste; parchment, shoes, harness, damp linen, corks of bottles, fruit, and vegetables also suffer from its attacks. Its chief food is, however, organic refuse. The house cricket lives through the year: the female lays her eggs in her burrows; they are long and sausage-shaped: the young which hatch from them are very similar to the parents, only they have no wings. The perfect insect is of an ochreous colour; head and thorax clouded with brown, the former is large, with two very long slender antennæ; the body is terminated by two tails; it has two oval membranous wing cases, and beneath them a pair of beautiful wings folded like fans: it has six legs, the hinder pair long, very stout, and formed for leaping; the shanks are spiny. The male is distinguished by a spot at the base of the wing cases, and the female has a long projecting organ or structure (ovipositor) for depositing her eggs: they are 1 in. long; the wings expand to 1¾ in. It is the male that makes the chirping sound by rubbing its wing cases one against the other. These insects dislike castor oil, and may be caught in bottles of sugar and water, treacle, or beer. [J. C.] [F. V. T.]

Guanaco, a wild species of the Llama which inhabits South America. See ALPACA.

Guanos.—The name 'guano' is derived from the Spanish *Guano* or *Huano*, which in turn was derived from the Peruvian *Huanu*, all of which words mean dung. It was applied originally to dried excrements and waste of sea birds which had accumulated through ages on the coast and on islands in rainless districts, such as are chiefly found on the Pacific seaboard of Peru and Chili. These original guanos were rich both in nitrogen and phosphates. The name is also applied to deposits of similar origin which have accumulated in climates which are not rainless, and where the nitrogenous constituents have undergone decomposition and have eventually been more or less removed by decay and solution in water. Such guanos consist largely of phosphate, and are known as phosphatic guanos. They may even become more or less consolidated into phosphatic rock containing either very little or no nitrogen, and known as crust guanos, guanorites, &c. The name has also been extended to include various artificial products made from waste flesh, blood, and bones of animals, from sewage products, from fish refuse, and other similar waste animal substances. Thus we have flesh and blood guanos, fish guanos, and so forth.

The earliest and greatest source of guano was the coast of Peru. Peruvian guano was first brought to Europe by the famous traveller von Humboldt in 1804. But it is said to have been used locally in Peru as a manure from the time of the Incas. It was not till 1840 that the first cargo of the manure reached England, but so rapidly did the consumption increase that five years later nearly 300,000 tons were imported. The importation continued in enormous quantities until the supplies began to get exhausted early in the 'seventies. The main deposits of Peruvian guano are now completely worked out, and the amounts imported are comparatively insignificant.

The interest of Peruvian guano is now mainly historical, but as no other manure ever played so important a part in the history of manuring, and in educating farmers to the use of concen-

trated manures, this chapter in the history of agriculture is not without its interest and importance. In order to understand the great effect produced by the introduction of guano we must take into account the conditions of agriculture at the time it was introduced, and the nature of the manure itself.

At the time when guano was introduced, agriculturists were quite unacquainted with concentrated manures. They knew only slow-acting and comparatively feeble manures, which had to be used in large quantities to produce any great effect. Dung, composts, and lime were the chief manures. Bones were used to a considerable extent, and were the only concentrated manure at all widely known. But at that period bones were only very roughly ground or crushed, and formed an even slower-acting manure than do the more finely ground bone meals of the present day. To this generation, ignorant of all manures but bulky dung and slow-acting bones, was suddenly introduced the most concentrated, quick-acting, and effective manure ever placed upon the market. We have no manure nowadays equal in all-round effectiveness and concentration to the early Peruvian guanos. The effect produced by this wonderful new substance was immediate and marvellous. Its fame spread with the greatest rapidity over the whole country. Everybody wanted to try it, and tales of its almost miraculous effects upon crops were passed from mouth to mouth. Its praises were sung by the writers of the day, and reached much beyond the ordinary circle of writers interested in agricultural affairs. Those who have dipped at all into the literature of the period must have come across many curious references to the impression produced by the introduction of guano. It brought about a kind of manuring boom, and in one lesson taught farmers more of the use and value of concentrated manures than they would have learned from a generation of agricultural lectures and textbooks. In this respect we may say that guano was one of the most important educative influences in agricultural chemistry ever introduced into this country. It commanded greater confidence among practical farmers than any other rapid and concentrated manure has ever obtained, and did much to prepare the way for the use of all other concentrated manures. Before it appeared, agricultural chemistry had already made sufficient advance to be prepared for it. Much was already known of the physiology and nutrition of plants, and guano came to give a great demonstration and practical illustration of what agricultural chemistry was prepared to do for farmers.

The old Peruvian guanos owed their high value and effectiveness both to their concentration as manures and to the varied states of availability in which their constituents existed. The best known of the early guanos was that obtained from the Chinchas islands, known as Chinchas guano. This manure contained commonly 14 to 16 per cent of nitrogen, 12 to 14 per cent of phosphoric acid, equal to about 26 to 30 per cent of tribasic phosphate of lime; and 2 to 3 per cent of potash. That is, it was as rich in nitrogen as nitrate of soda, and at the same time as rich in phosphate as a good sample of superphosphate, while in addition it contained a little potash. Part of its nitrogen was soluble in water and of immediate availability to plants. This part existed mainly as salts of ammonia, but a small amount of nitrate was also present. The remainder of the nitrogen was contained in uric acid, and other organic compounds of a kind which easily decomposed in the soil and became available for the use of plants. Similarly with the phosphoric acid, part of it was soluble in water and therefore in the state of greatest availability, while the rest, though not water-soluble, was contained in compounds at least as available as the phosphate of bones. It was therefore suited to supply the soil both with soluble constituents ready for immediate consumption by plants, and with constituents which, as the soluble substances became exhausted, continued the work by becoming gradually available. It was the ideal manure, both rapid and lasting in its effects.

The manufacturer of high-class mixed manures at the present day attempts to produce similar results by mixing nitrogen in the various forms of nitrates, sulphate of ammonia, and organic nitrogen, and phosphates, both as soluble phosphate of superphosphate and as insoluble phosphates, into his manures. But no mixture which he can make, using even the most valuable and concentrated materials now available, such as nitrate of soda, sulphate of ammonia, dried blood, fish guano, superphosphate, and bone flour, will be as concentrated as a Chinchas guano.

The great deposits of concentrated guano such as those of the Chinchas islands were limited in extent, and with a consumption that reached nearly half a million tons per annum they soon began to become exhausted. It is estimated that the Chinchas islands yielded some ten million tons of guano. The other deposits were of less importance, though some of them yielded guano of even richer quality than Chinchas. Angamos guano, for instance, contained up to 19 per cent of nitrogen.

As the supply of Chinchas guano became exhausted, guanos from various other sources were drawn upon, and the quality of guano gradually fell. Supplies were obtained from other parts of the Peruvian coast, and from the coasts of Bolivia, Colombia, and Patagonia. In addition to these South American sources, guanos were obtained from points on the coasts of Australia and south-west Africa, from certain islands in the Pacific, and from other places. These guanos vary greatly in quality, and in no other place has guano been found in such quantity and of such quality as in the Chinchas islands.

At present the amount of guano annually imported into this country is a mere fraction of what was imported forty or fifty years ago. In 1901 the total import was 13,000 tons, and in 1907, 31,278 tons. These figures include guanos of all kinds, much of which is phosphatic guano, containing very little nitrogen.

Present-day guanos seldom contain more than

10 per cent of nitrogen. Peruvian guanos recently imported have contained nitrogen from 2½ to 11½ per cent, equal to ammonia from about 3 to 14 per cent; phosphate as tribasic phosphate of lime from about 15 to 42 per cent, and potash from 2 to 4 per cent. Some of the richest of these consist of recent deposits. The rich old guanos consisted of dung and waste of sea birds which had accumulated through ages, and had become consolidated and concentrated by desiccation, chemical change, and pressure. The sea birds still inhabit their old haunts on the coasts of Peru and elsewhere, and are still depositing dung, remains of their food, and other waste substances. The newly accumulated deposits of these are collected from time to time, and much of the modern nitrogenous guano is obtained in this way. These recent guanos contain feathers and other easily recognizable materials. Not only are they not so concentrated as the old Chinchas guanos, but as the constituents have not undergone the same amount of chemical change they are not so available to plants. For instance, modern high-grade guano does not contain nearly so much ammonium carbonate, and does not smell nearly so ammoniacal as an old Chinchas guano.

As the supply of guano fell off after 1870, the demand did not fall equally. Farmers had been brought up to look upon guano as the concentrated manure above all others, and had faith in its virtue such as they have never placed in any other artificial manure. The result was that the price of guano rose, and for a long time, though it was falling off seriously in quality, its price remained very high. Even at the present day, when a generation has passed away since Chinchas guano was exhausted, the tendency is for guano to be dear as compared with other manures of equal value. The scarcity and high price of guano placed great temptation to adulteration in the way of unscrupulous dealers, especially as guano was an easy manure to adulterate. Probably no manure was ever more extensively tampered with than guano. The generation which used most guano knew little of agricultural chemistry, and had no means of judging of the value of this costly manure except by the very imperfect and uncertain guides of smell and appearance. The outcry caused by the general suspicion that guano was systematically adulterated did a great deal to promote agricultural analysis for the purpose of checking adulteration, though the Government did not intervene with legislation to check this form of adulteration till the most crying need for it was past (see FERTILIZERS AND FEEDING-STUFFS ACT).

Modern guanos vary so much in quality that the purchaser should see that the price corresponds with the percentages of the valuable constituents nitrogen, phosphate, and potash which he is obtaining. He would also be well advised to have samples analysed from time to time. Guanos are commonly divided into nitrogenous and phosphatic. Nitrogenous guanos are those which contain a considerable percentage of nitrogen, generally over 4 per cent. They may also contain a large percentage of phosphate. A recent sample, for instance, contained 6·3 per cent of nitrogen and 32 per cent of phosphate. Phosphatic guanos, on the other hand, contain little nitrogen, generally from 1 to 3 per cent, but they should contain a considerable percentage of phosphate. Usually the phosphate is from 30 to 50 per cent, but samples containing as much as 70 per cent are sometimes on the market. Neither the nitrogen nor the phosphate of a phosphatic guano are worth so much as those of a high-grade nitrogenous guano. Owing to the conditions under which it was formed, practically all soluble constituents of phosphatic guano have been washed away, and everything is insoluble and comparatively unavailable to plants. The phosphate is practically all tribasic phosphate of lime, and is not more available than that of a well-ground sample of bones; similarly the nitrogen is all contained in slowly available insoluble organic compounds. The nitrogen and phosphates of phosphatic guanos are not worth more per unit to the farmer than those of well-ground bones, but owing to the demand which still exists for guanos, they generally cost more. On the other hand, a considerable portion of the nitrogen and phosphates of high-grade guano are soluble, and a still larger proportion readily available to plants. These constituents, therefore, are worth a higher unit price in such a guano than in a phosphatic guano.

A certain amount of guano, especially phosphatic guano, is mixed with other manures or dissolved. Equalized or fortified guano is guano which has been enriched by the addition of sulphate of ammonia, and sometimes of potash salts and other substances. Dissolved guano is phosphatic guano which has been treated with sulphuric acid to make a part of the phosphate water-soluble. Guanos, and especially the lower-grade guanos, are frequently introduced into mixed manures, and sometimes such mixtures are sold as guano mixtures or compounds.

Deposits of the dung and waste of bats have been found in some quantity in caves in different parts of the world. The term bats' guano has been applied to this manure, which is somewhat similar to Peruvian guano. It may contain a considerable percentage of nitrogen and phosphate.

Since the earliest times the dung of pigeons has been highly valued as manure. Considerable deposits of pigeons' dung and waste sometimes accumulate during long periods in dovecots, and the term pigeons' guano is sometimes given to this manure. In a recent sample, obtained from a Perthshire dovecot, where it had accumulated for nearly half a century, the writer found only 2·35 per cent of nitrogen and 6·42 per cent of phosphates. The moisture was 30·47 per cent, and probably the manure had lost much through washing and decay in our moist climate. It also contained 32·3 per cent of siliceous matter. Nevertheless it was very highly valued locally, and some of it was sold at a price far beyond its real value.

The name guano is so popular that it has a value of its own when applied to manure, hence it has been given to various materials which are

not derived from the dung of birds and have no real right to the title. The most important of these so-called guanos is fish guano, which is an extensively used and valuable manure (see FISH MANURES). Other 'guanos' are made from waste meat and bone, such as that which is produced as a by-product by the manufacturers of extracts of meat, or from the meat, blood, and bone obtained at knackeries. Some of these are manures of high value.

On the other hand, the name guano is sometimes given to the most rubbishy manures. Some of these, to which high-sounding names are given, are really low-class mixtures of cheap materials of little manurial value. [J. H.]

Guava (*Psidium Guyava*, nat. ord. Myrtaceæ), the fruit of a small evergreen tree, probably originally a native of South America, though now extensively cultivated throughout the Tropics, both of the Old and the New Worlds, and

White Guava—Flowers, Foliage, and Fruit

in many cases become so completely acclimatized as to be often spoken of as wild. The tree is grown solely for its edible fruit. There are said to be two chief varieties, one the pear-shaped or white guava (var. *pyriferum*), the other the apple-shaped or red guava (var. *pomiferum*). Young plants may be raised by seed or by layers or root-suckers. No particular cultivation is necessary; the plant thrives practically on any soil, and is capable of enduring a wide range of climatic conditions. It begins to flower (according to environment) about February to March, and continues to do so for some months, yielding fruit right up to the close of the year, the best quality being as a rule obtained during the last month of the fruiting season. The fruit may be eaten as a dessert, but is usually preferred by Europeans when stewed or made into preserves. Guava jelly and cheese may be said to be famed throughout the world, and are largely imported by Europe from both India and the West Indies. Indian production may be spoken of as constituting a speciality of the Southern Presidency. [G. W.]

Guelder Rose. See VIBURNUM.

Guenon System or Escutcheon Theory. — The escutcheon or 'milk mirror', which is peculiar to all the bovine race, although not noticeable by an ordinary observer until specially pointed out, was first discovered by François Guenon at the beginning of the 19th century. He classified and reduced the various escutcheons to such an intelligible system, that at this distance of time those who have studied the subject thoroughly and worked it out practically on Guenon's lines have found that his interpretation of the various markings still holds true. A short biographical sketch of the man and his methods is necessary to understand the subject.

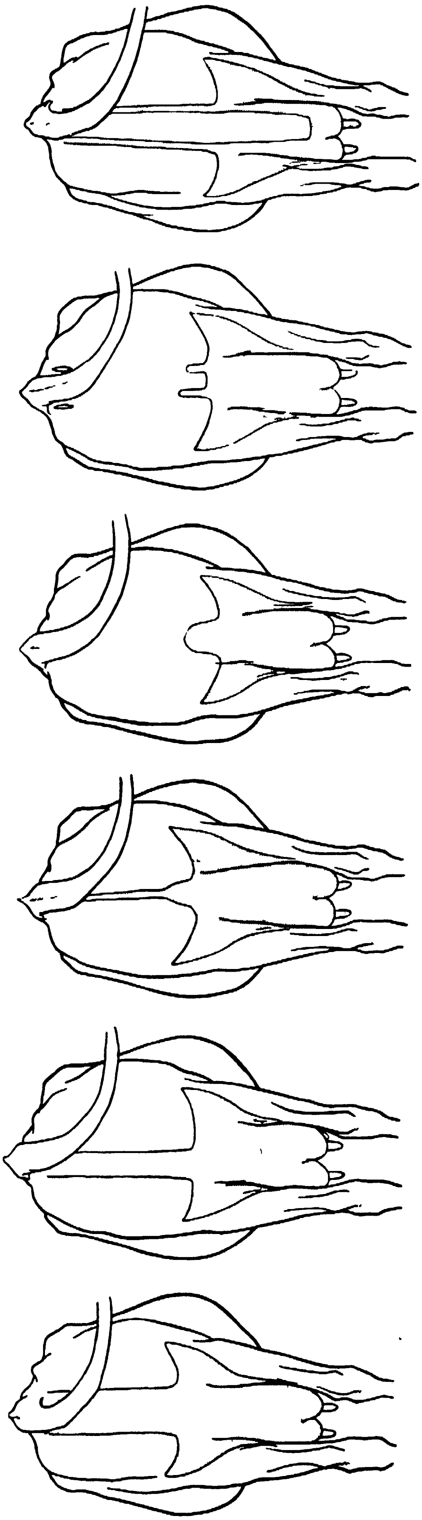
François Guenon was the son of a French gardener who made arboriculture his study, and in later years the cutting of 'trees, grafts, both splits and bandages', became his 'principal work', so that by that means he gained 'an insight into classification'. As a lad of fourteen he had to tend his father's cow, and being fond of animals he used to 'clean and scratch' his old companion. He then observed for the first time the fact that the hair on the udder and thighs grew in 'opposite direction' to the hair on the legs, and he 'noticed a sort of bran or dandruff which detached itself in considerable quantities from certain spots on the hind parts where the two lots of hair met' (How to Select Cows on the Guenon System). He was so much struck with this discovery that he examined other cows for this 'dandruff', and found 'great diversities existed among cows in respect to the shape of the bearded ears which produced the dandruff'. These shapes suggested a new train of reflection and observation, 'which resulted in his becoming convinced that they were the signs by which to distinguish cows, and to know the good and bad qualities of every individual among them'.

Applying the knowledge that he acquired in arboriculture, Guenon classified the various escutcheons which he found on different cows, and eventually published a Treatise on Milch Cows, giving all the information he had collected, accompanied with illustrations. In the preface to the second edition, writing of the various markings, appears the following paragraph: 'Unknown up to this day, although they have always existed, these signs have escaped all the world, even the sagacity of the most celebrated painters, as well as that of veterinary doctors of the highest reputations of all times'.

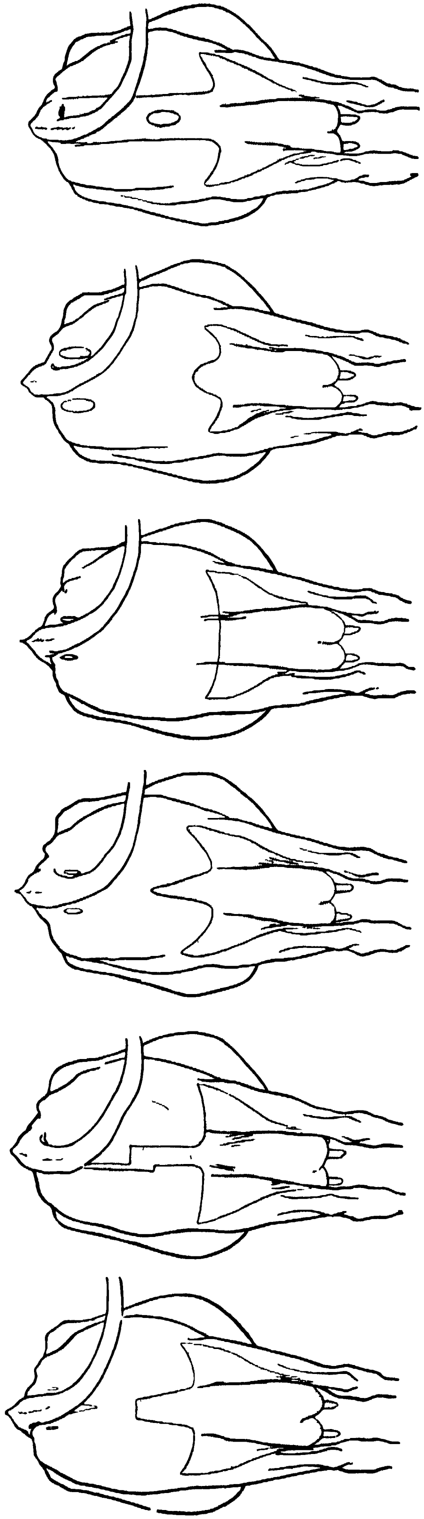
Guenon's reputation now began to grow. He submitted to tests before various agricultural societies in France with great success, in one instance 'gauging the worth of a lot of cattle before fifty of the most eminent agriculturists, his estimates being correct in all but one, of the quantities of milk; in all but one, of the period of lactation; and again in all but one, of the quality of the milk' ('Economics in Dairy Farming').

Guenon died full of age, riches, and honour. He received money, medals, and decorations from various societies, and a pension of three thousand francs a year for life from the French Government—a position won entirely by merit,

GUENON SYSTEM—I



THE FLANDRINE THE LEFT FLANDRINE THE SELVAGE THE CURVELINE THE BICORN THE DOUBLE SELVAGE



THE DEMIJOHN THE SQUARE THE LIMOUSINE THE THIGH OR HORIZONTAL ISCHIATIC TUFTS PERINEAL TUFT

DIAGRAMS OF ESCUTCHEONS. (Reproduced from *Economies in Dairy Farming*. By permission)

and by the belief in the practical value of his system, since he had 'neither means nor influence to bring him into notice'.

The escutcheon is formed by the upward growing hair on the thighs and udder of a cow. It commences as low down as the hock on the leg and from the front of the udder, and extends upwards to the vulva, stretching out on the thighs in the form of an heraldic shield. The escutcheon can best be traced by passing the hand over it, when 'the upward growth of the hair which forms the escutcheon can be easily distinguished from the descending hairs'.

Guenon classified ten orders of escutcheons, and to each order four grades, placing the perfect specimens in the first grade, the next best in the second, and so on. The ten orders of escutcheons, which took their names from the figures shown on the back of the udder, were called by the following names:—

1. *The Flandrine*—a broad band running up the back of the udder to the vulva.

2. *The Left Flandrine*—a band half the width of the Flandrine and on the left-hand side.

3. *The Selvage*—a narrower band at the top, but broad where it first commences, and running up to the vulva.

4. *The Curveline*—a semicircular figure running only a short distance up the udder.

5. *The Bicorn*—two small horns starting from the top of the shield, running a short way up the udder. On either side of the vulva two small tufts of ascending hair are also found, as if they were continuations of the horns.

6. *The Double Selvage*—like the Bicorn, only the horns extend up to the vulva.

7. *The Demijohn*—like the Curveline, only with a square top.

8. *The Square Escutcheon*—like a demijohn, only that a narrow band of ascending hair continues upwards from the left-hand side.

9. *The Limousine*—like an isosceles triangle, with tufts the same as the Bicorn.

10. *The Horizontal Escutcheon*—a plain shield without any ascending markings, stretching quite squarely across the udder.

In all these cases the markings on the thigh should be the same, viz. two broad half-shields spreading out well on to the thigh, and the higher up that they extend the better will be the cow. The markings on the thigh are the most important, although the markings up the back of the udder are confirmatory of the capabilities of the cow for milking. As a general rule, it may be taken as correct that the higher up on the thigh the shield markings extend, the longer will the cow keep up her flow of milk, while the broader the markings are on the thigh the larger will be the yield of milk. Of the ten classes of escutcheons mentioned above, those most usually found, and the best, are the Flandrine, Left Flandrine, Selvage, Curveline, and Limousine.

Such is a brief description of the escutcheons as classified by Guenon; but to appreciate the value of the cow for milk from the shape alone, a knowledge of the 'tufts' or 'ovals' is absolutely necessary. The classification of the shield is comparatively easy, but the difficulty in appreciating these two subsidiary markings is considerable.

Guenon was of opinion that all tufts of hair encroaching on the escutcheon diminished its value, and he consequently urged very close examination into these peculiarities, as want of this scrutiny even in his time caused the same sort of mistakes in estimating the value of a milch cow as it does now. He divided these into seven classes:—

1. *Oval tuft.*—Two ovals of descending hair. These are good signs, and are usually found on the udders of the best milkers. They are an exception to the rule of encroaching tufts of hair. The hair should be fine and silky, and when once learnt there will be no difficulty in finding them again.

2. *Ischiatic tufts.*—Two tufts of hair on the vertical part of the escutcheon, on one or both sides of the vulva. The hair ascends, and frequently the tufts are bordered with bristly coarse hair. These are bad markings, and take away from the value of the escutcheon.

3. *Lip-shaped tuft.*—This is another bad sign, and is found only in the Flandrine and Left Flandrine classes. It is of descending hair, like a string, hanging over the top of the vulva. It is not often seen.

4. *Vulvan tuft.*—This is another bad sign. It is a tuft of descending hair under the vulva, and found only in those escutcheons which extend up to the vulva.

5. *Mesian tuft.*—This is a very good mark. Like the last, only in the shape of a V, and of ascending hair, it is found under the vulva: but only in those classes where the escutcheon does not extend up to the vulva.

6. *Perineal tuft.*—This is also called a bastard mark. It consists of an oval of descending hair in the Flandrine escutcheon, generally about halfway up the vertical markings. Cows with this mark have usually the best escutcheons, and are heavy milkers until they get in calf, when the yield of milk at once falls off. This marking is very easy to be seen, and is most reliable.

7. *Thigh tufts.*—These diminish the size of the escutcheon on the thigh, and consist of coarse descending hairs encroaching on the escutcheon. Although not classified, it may be accepted as generally a very bad sign when the hair bordering the vertical escutcheon is coarse and wiry.

Escutcheons are not confined to females, but are also seen on bulls, the Curveline, Limousine, and Horizontal being most usual, although occasionally a Flandrine may be found. The markings on the thighs of a bull are, or should be, a *sine qua non* in purchasing or keeping a sire for dairy purposes. The escutcheon markings can also be seen in calves, and therefore one of the 'principal practical uses to which a knowledge of the Guenon system can be applied is in selecting calves to keep for the milking herd' (How to Select Cows).

The Guenon theory, if studied intelligently, thoroughly understood and practically applied, is of the greatest possible use to breeders of milking stock. Unfortunately most breeders are content to get a 'smattering' only of the

system, and consequently, not appreciating it or being able to diagnose the various markings correctly, they condemn it without cause.

It is possible to find cattle with good escutcheons that do not come up to the expectation formed of them; but there always are exceptions to every rule, and it is possible in many cases that the value of the cow as a milk producer may have been irretrievably spoiled in her early days, either by over or under feeding. There is a happy medium in rearing calves for the dairy that is too frequently lost sight of; in some cases they are underfed, but in most the reverse is the case.

It cannot be too well understood that overfeeding a heifer, as if for the butcher, will invariably destroy her milk-yielding propensities, or so impair them that as a dairy cow she will be a failure.

A great deal more could be written on this subject; but the following extract from the report of a commission appointed in Philadelphia to test the Guenon theory in 1878, after examining 200 cows, heifers, and bulls, may aptly serve as a conclusion to this article:—

'The result of their examinations has been to convince themselves and others of the merits of the system, of its exceeding value to the practical farmer, and they believe that if generally followed for twenty years the value of the neat cattle of the State would be increased vastly, the amount of milk and butter produced would be much larger, and the quality of both articles better, while the quality of the meat would be improved. . . . As an adjunct to previous knowledge, to assist purchasers or breeders of cattle in getting or raising the best and weeding out the poorest, they think it is worthy of being acquired by every farmer. . . . Any intelligent man can readily master the system, and soon become proficient in it by practice. This knowledge, applied with the tests heretofore usually used, will enable anyone to become a good judge of cattle.' [E. M.]

Guernsey, Agriculture of.—Guernsey is much less favoured than Jersey in respect of climate and aspect. Frost in spring is less uncommon in the former island than in the latter, while the land of Guernsey, instead of sloping towards the south, as in Jersey, inclines towards the north. Consequently the island is much less suited to early potatoes than Jersey is, and indeed for intensive cultivation in the open generally, and rents accordingly are not so high. The enterprise of the people, however, has resulted in the covering of a great area of land with glass, so that the productiveness of the island is quite out of proportion to its agricultural area.

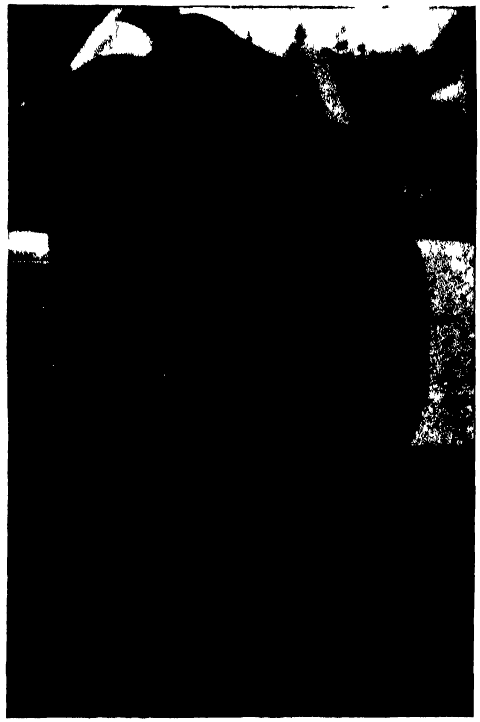
Statistics for Guernsey are for its bailiwick, which covers Alderney, with Sark and the other small islands, which are not of any considerable importance from an agricultural point of view. The total area under crops and grass in 1907 is put by the Agricultural Returns at 11,357 ac.; but this covers only holdings over 1 ac., and in Guernsey there is a great number of holdings of less than an acre, purchased by working men and others for dwellings, glass-houses, and the cultivation of vegetables and flowers. For th reason the figures relating to the sizes of hol ings are apt to convey a wrong impression, also are those relating to the proportions owners and tenants. This wrong impressi is accentuated by the fact that in Alderney large proportion of the land is rented, while o small island is, or was recently, in the hands one tenant. The number of holdings over 1 and not exceeding 5 ac. each was 527 in 190 that of holdings over 5 and not over 50 ac. bei 685, while only 7 were over 50 ac. These figur make the total number of holdings over 1 1219, and the average size of a holding 9·3 a but local statistics published some years a made the total number, including those und 1 ac., 2506, and the average size of a holdi 4·7 ac. About 75 per cent of the holdings, a cording to the earlier statistics, were in t hands of the owners.

Of the 11,357 ac. of land under crops a grass, covering holdings over 1 ac., in 19 5362 ac. were arable and 5995 under grass, t latter area being made up to a considerab extent by the acreage of Alderney and the oth small islands. Only 1038 ac. were under co crops, more than half of which area was devot to rye, mainly, it may be assumed, for cutting f forage when green. Potatoes occupied 651 a roots, cabbages, tares, and similar forage cro 710 ac.; small fruit, 282 ac.; clovers and grass under rotation, 1066 ac.; 'other crops', large consisting of culinary vegetables and tomato 1461 ac.; and bare fallow, 154 ac. Culina vegetables and flowers are largely grown f export. In former times a common course cropping was one of mixed seeds, wheat, pa snips, potatoes, and roots or some other feedi crop, the land being in temporary pasture f two or three years. A more usual course f some years past has been one omitting whe and growing potatoes followed by broccoli turnips in the same season after two or thr years of seeds, and potatoes again, with or wit out broccoli to follow that crop. Broccoli is o of the most profitable crops in Guernsey.

Live stock in 1907 consisted of 1609 hors 6761 cattle, 174 sheep, and 4137 pigs. The catt are exclusively of the Guernsey breed, and, apa from those sold at home and abroad as breedi stock, they are used mainly for buttermaki Guernsey butter has a high local reputati although, as it is mainly churned into a lu from soured milk, it contains a large proporti of casein, and does not rank high in the opini of English connoisseurs. There is a conside able residential population in Guernsey, ho ever, and there is a good local sale for the butt at high prices.

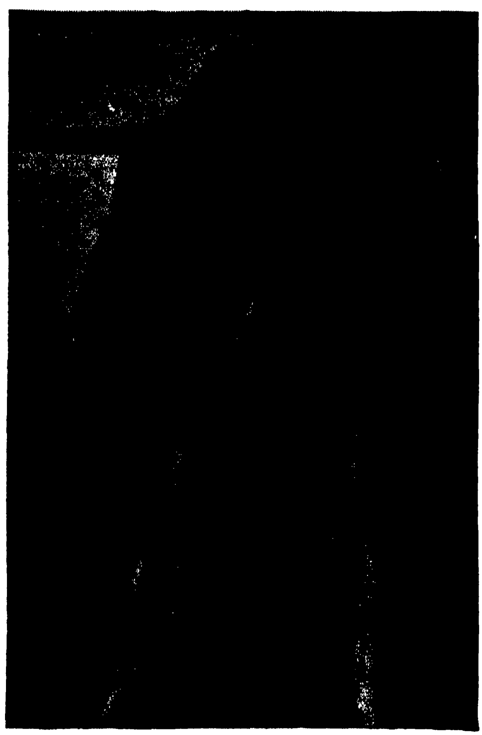
A large acreage is covered by glass-hous some heated and others cool, grapes, tomato melons, potatoes, peas, and French beans bei grown in them. A great number of workm own a small plot of land, on which they ha each erected a dwelling and a cool glass-hou while those who have sufficient land grow cu nary vegetables and flowers for market in t open. Exports of glass-house products and vegetables, fruit, and flowers grown in the op

A FLANDRINE ESCUTCHEON
(Shorthorn)



A FLANDRINE ESCUTCHEON
(Jersey)

A CURVELINE ESCUTCHEON



A SELVAGE ESCUTCHEON

bring a large sum of money annually into the island.

Alderney is chiefly devoted to grazing, though wheat, oats, and late potatoes for winter are grown to some extent. The cattle are of the Alderney breed, now hardly distinguishable from the Guernseys. The smaller islands, as already stated, are of no considerable agricultural importance. [W. E. B.]

Guernsey Cattle. — Although for many years the writer has been intimately acquainted with Guernsey cattle, both in England and in the island, and has written many articles upon them, yet he has found it exceedingly difficult to trace their early history. Even the valuable and kindly assistance of two gentlemen in the island, who are the greatest living authorities on its history and antiquities—the Rev. George Lee, the rector of St. Peter Port, and Colonel de Guerin, a jurat of the Royal Court—can throw no light on the problem. Even after the time of Duke Robert, the father of William the Conqueror, it is next to impossible to ascertain anything of the cattle then existing on the island. Naturally, therefore, we surmise that in the first instance the cattle must have been brought from Normandy—the nearest part of France to the island. In later times, there is no doubt that colonies or detached bodies came over to the island from the great and celebrated Le Mont St. Michel, and that monastic establishments were founded at the Vale and also on Lihou Island, both in connection with the great body at St. Michel. From time to time the islanders carried their spare produce, corn, or other commodities to this St. Michel, and it is only reasonable to suppose that cattle for the purpose of breeding were conveyed on the return voyage to Guernsey. As far as is known, or can be supposed, these cattle came from Normandy, and the appearance and points of the Guernsey of to-day show distinct evidence of Norman descent, just as the Jersey breed exhibits many of the characteristics of the cattle of Brittany. In frame, in colour, in touch of skin, the Guernsey of to-day much resembles the somewhat larger animal from Normandy. Doubtless the Normandy animal of to-day is larger than the Guernsey, but that can easily be accounted for by the inbreeding on the island. This latter circumstance has been rendered unavoidable by the law which prohibits the importation of any cow, except for the purposes of slaughter, and rigidly excludes all bulls whether alive or dead. It has been surmised that the religious authorities at Mont St. Michel from time to time sent over bulls to improve the breed of cattle in the island, but the author has been unable to find any direct proof of this. The following words, quoted from an authoritative source, may throw a further light on my subject: 'The Guernsey cattle came originally from a cross between the brindled herds of Normandy—those of the Ange Valley in the Cotentin, the fawn-coloured herds of Brittany, being mainly used. The famous "Léon" stock was chiefly selected.'

One point alone seems clear, that the breeds in the two islands of Jersey and Guernsey have always been carefully kept apart. In Alderney the cattle have always been the same breed as those in Guernsey; but they show signs of having at some time or other been crossed with Brittany cattle. This is seen in the smoky muzzles, dark hair on the ears and neck—features which are absent from Normandy cattle. At the Royal Agricultural shows the Channel Island cattle were at one time not only known but classified as Alderneys. At the famous show at Kilburn in the year 1879 it was so. This seems rather strange, seeing no Jersey may land in Alderney or Guernsey, or one from these latter islands in Jersey. In both Guernsey and Jersey herd books are kept, and by the exertions of General Campbell, the Governor of Guernsey and Alderney, one was established in Alderney in 1906.

In the years 1819–24 ordinances of the Royal Court were passed, forbidding importation of bulls, cows, or heifers. These ordinances, which remained in force till 3rd October, 1842, were thereafter somewhat relaxed. The importation of cows and heifers was allowed, on condition that they were to be slaughtered or re-exported within six months; in 1857 the time was reduced to three months. Various other ordinances were passed in succeeding years as to importation, enforcing branding and compulsory slaughter. About the year 1895 many cattle were sold to English breeders for exhibition purposes. Naturally the Guernsey farmer was anxious to exhibit as well as sell, and an agitation was started to get an ordinance passed allowing cattle to be shown in England and reimported. This was granted in January, 1903, but owing to the outbreak of 'foot-and-mouth' and some cases of 'pleuro' in England it was repealed in April, 1907, and the old ordinance prohibiting the importation of all cattle again came into force, and still remains so.

About the year 1880 nothing could have been more delightful to the lover of cattle than to visit the island of Guernsey. Everywhere you could find really beautiful animals; the herds, it is true, were small, for the holdings have always been small. The farmers, with the assistance of wives and daughters, tended their own cattle. Such a thing as exporting to England for show purposes was quite unknown, and prices were those one would expect to find where demand beyond local needs was small. The American buyer had not been heard of; the English one in only a small way. The Rev. Joshua Watson was about the first man to send cattle to the English shows. He had splendid cattle, and at once took prizes for them in England, where they were classified as Alderneys. The favour they experienced among English agriculturists soon resulted in classes for Guernseys only being formed at the shows of the Royal Agricultural, the Bath and West, and Royal Counties Societies. Mr. James James, of Les Vauxbelets, a Scotchman who had settled in Guernsey, was soon in competition with Mr. Watson at English shows, and, like him, had splendid cattle. Some years after this, the fruit-growing industry started, at first, it is true, in a small way, but the Guernsey climate and soil

proved so suitable to the grape and tomato grower that glasshouses sprang up like mushrooms, and in the 'nineties the homes and most luxurious pastures of the Guernsey cattle knew them no more. In 1880, except in the Parishes of the Vale and St. Sampson's, glass was unknown; in 1890 it was everywhere. Naturally the number of cattle was seriously diminished; the farmers became growers. Many of them would like to become farmers again, for the glass business is now a failing one. Foreign competition and glasshouses in England have sadly diminished the profits, whilst the Guernsey cow is still in favour. American buyers continue to come and pay extremely high prices for them. The year 1908 was an exceptionally fortunate one for Guernsey cattle breeders, the American demand being greater than ever, and the prices likewise on the whole being larger. Perhaps the years when Guernseys were most fancied in England were during the years 1885 to 1903. In the year 1889, at the great Jubilee Show of the Royal Agricultural Society at Windsor, where the present writer was one of the judges, the number of Guernsey cattle entered was no less than 185. The champion cow Pretty Dairymaid, the property of Mr. Dan Le Patourel of Les Quartiers, Guernsey, was sold to go to America for the sum of £150. After that, many large herds were established in England, that of Mr. Glynn in the Isle of Wight, and the writer's, first in Suffolk and then in Hampshire, being amongst the largest. A large Guernsey Cattle Society was formed in England, and in 1885 a herd book instituted. The number of entries in it was 383. In the volume No. 23, published in 1907, the number had reached 9042. Notwithstanding this, the Guernsey entries at the various shows are not so large as they used to be, and many of the largest herds are no longer represented at them. The old owners have passed away, and the new ones have not the same interest in, or do not care to incur the expense of exhibiting at the agricultural shows. Turning to Guernsey itself, many of the older breeders have passed away, though some still remain—Mr. Thomas Le Prevost, Mr. Ozanne of Le Pelley, Mr. Jehan of St. Martin's, Alfred Le Patourel of La Mamee. As previously mentioned, a large number of cattle were exported in the year 1908, and in the first two months of 1909 Mr. Jauncey, of the United States, shipped for New York over 120 head, some of which reached from £110 to £190, the average price realized being from £50 to £70 per head.

Many years ago two herd books existed in Guernsey—the Royal Agricultural Society's and the 'General'. The latter, fortunately, became merged in the former. There is now a very excellent Herd Book Committee, and local shows are frequently held at which cattle are examined by expert members of the society before being allowed to be entered in the herd book. The English Guernsey Society's Herd Book is compiled with the greatest care, and the owner of every imported animal has to produce a certificate from the Guernsey Society before it can be registered. Guernsey cattle are now to be found in large numbers all over the south of England, specially so in Hampshire, Somerset, Cornwall, and Devonshire. In the New Forest one hardly sees any other breed, and the farmers and cottagers alike value them highly for their great milking powers. In Cornwall particularly there are several large and excellent herds, and indeed the very best specimen of a Guernsey cow is to be found there in Colonel Glynne's Golden Horn, the winner of many championships and other prizes. In Kent is to be found the herd of Mr. Hambro, a very wealthy breeder, who purchases the very best to be found in the island, and at present has the most perfect herd in England. The other most famous and successful breeders and exhibitors, besides those already named, are: Mr. Hargreaves in Bedfordshire; Lady Tichborne, who has for many years been one of the largest and most fortunate of exhibitors, in Hampshire; Sir Henry Lennard and Mr. Plumptree in Kent.

It might be well to add here the 'points' of the Guernsey breed, taken from the authorized scale adopted in the year 1905 by the English Guernsey Cattle Society. Those of the Guernsey Island Society are very similar.

1. Head fine and long; muzzle expanded; eyes large, with gentle expression; forehead broad; horns curved, not coarse.
2. Long thin neck, clean throat, chine fine.
3. Back level to setting-on of tail, broad and level across loins; thighs thin and long; tail fine and long, good switch.
4. Ribs amply sprung and wide apart; barrel large and deep.
5. Hide mellow and flexible, closely covered with fine hair; cream-coloured nose.
6. Escutcheon wide on thighs, high and broad, with thigh ovals.
7. Milk veins prominent, long, and tortuous, with large deep fountains; udder full in front, full and well up behind, of large size and capacity; teats well apart, squarely placed, and of good size; skin yellow in ear and end of tail, at base of horns, on udder, and body generally; hoofs amber-coloured.

We must now touch on milking qualities, as proved by trials and butter tests. In Guernsey it is only recently that these trials have been carried on, but in England both the Jersey and Guernsey societies promote them and give good prizes. Some results published in the report of the British Dairy Farmers' Association in 1900 may be given here: First prize Guernsey cow in milking test gave 81·6 lb. in forty-eight hours—four milkings equal 4 gal. per day. This cow had been 136 days in milk. In 1908, at the Royal Counties Show at Southampton, the best cow gave 38 lb. 14 oz. in twenty-four hours—equal to nearly 4 gal. This cow was recently calved, having only been in milk eight days. At the dairy show above mentioned, the second winner gave 88 lb., and the third 83 lb.—a larger volume of milk, but poorer in butter fat than that of the winner. At the same shows the butter tests were as follows: At the dairy show, the winner of the silver medal, which had been 173 days in milk, gave 1 lb. 8 oz. At Southampton the winner gave 2 lb. 1½ oz. in twenty-four hours, having been 8 days in milk,

Photo G H Parsons

GUERNSEY BULL — MERION SIGNET

WINNER OF 1ST PRIZE, R A S E SHOW, 1908

Photo G H Parsons

GUERNSEY COW—"FI II"

WINNER OF 1ST PRIZE, R A S E SHOW, 1908

and won the second milking prize. In 1901, the celebrated cow Florence, the property of the writer, gave at the dairy show 2 lb. 4 oz., having been in milk 151 days, besides having been at all the shows during the year. It should, however, be said that on usual, not forced, feeding, the winter average of milk is about 2½ gal. per day. This, of course, might be forced up to 3 or 3½ gal. A fair summer average is 3½ to 4 gal. No doubt there are exceptionally fine milkers which yield more, but only the average yield is given here. In Guernsey little or no artificial food is given, the farmers growing parsnips chiefly for the winter supply of their butter cows, whilst the milking cows are fed largely on what is described as 'bucket'—giant bran and hot water. It must be remembered that the larger proportion of the milk is sold as milk and not made into butter. Owing to the great decrease of pasture land the number of cows in Guernsey has also much decreased of late years, and the supply of butter is mainly English factory butter, that made in the island selling in winter at 2*s.* to 1*s.* 8*d.* per lb. and never falling below 1*s.* 5*d.*

With regard to Guernsey beef, it has to be acknowledged that, except to the islanders, it is not in favour. The very bright colour of the flesh is disliked by visitors; but there is ready sale at high prices for all that can be produced. We need not refer to cow beef, but the best three-year-old steers average from 600 to 700 lb., and for prime joints, high prices are asked, 1*s.* to 1*s.* 3*d.* per lb. Many old Guernsey and Jersey cows are daily brought from England for slaughter, but a very large quantity of chilled and frozen meat is brought over. The island could not supply a quarter of the meat required, or indeed anything like it. In conclusion, one might say that prices have of late ruled high, chiefly owing to the great demand for Guernsey cattle. Buyers in England of late have not been giving so much, on account of bad times. The writer was offered £220 for his prizewinning cows Jessie and Florence, which were never beaten except by one another, and £180 was offered and refused for Jessie alone to go to the United States.

In many large dairies in England where Shorthorn, Ayrshire, or other breeds form the milking stock, two or three Guernseys are kept for the sole purpose of enriching the milk of the entire dairy and adding colour to the butter. In Guernsey herds the butter is of such a rich yellow colour that it gives rise to suspicions of artificial colouring. This, however, is obviated when the milk of two breeds is blended. The Guernsey cattle are easily managed; they are hardy and have strong constitutions, and may be allowed to go out all through the winter, provided they are not kept standing in cold, wet weather. Undecorticated cotton cake is one of the most useful foods, and for at least nine months of the year from 3 to 5 lb. per head may profitably be given. In winter the writer uses dried grains. These are scalded and given warm each morning. The very best are obtainable from the English Grains Co., Burton-on-Trent, and the average price is £5 per ton. These grains are preferable to wet grains, that is those sent straight from the mash tub; and indeed the writer esteems these latter as of little value.

As has already been mentioned in this article, the chief buyers of Guernsey cattle in the island itself are Americans, although a few of the best are bought by English exhibitors; but they are not willing, or perhaps able, to give the large prices that the agents of American millionaires continually do. No more useful or profitable cow can be bought by a small farmer than the Guernsey. Good honest milkers and butter producers are still to be had for £18 apiece, of good size, colour, and value, though of course these would not be animals for the show yard.

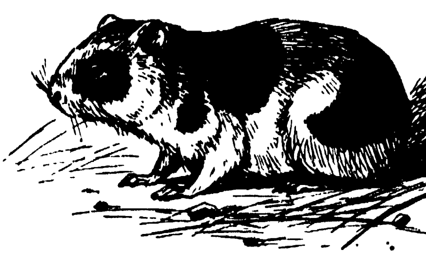
Much might be written on each and every one of the points that have been touched upon. The Guernsey is a charming animal and very productive, and no milking breed so well repays care and kindness. [A. B. H.]

Guinea Fowl. — The number of guinea fowls kept in this country is comparatively small, due to the fact that the demand for these birds is limited to a few weeks in the very early period of the year, and also to the fact that the guinea fowl has the reputation of being amongst the most ill-tempered of all poultry breeds, and somewhat difficult to keep with other birds. If, however, there is plenty of room for them to wander about, and if they can be allocated a separate house, the returns are very good. The type of guinea fowl which is generally kept is very uniform in colour of plumage. In the majority of cases the ground colour is of a dark-purplish-grey with white spots. It is usual to keep one cock to six or eight guinea hens, and being excellent foragers they cost very little to keep. As a rule, a good laying hen will produce sixty to seventy eggs per annum, and the period of hatching is twenty-six days. Great care is required during the chicken stage, as the young birds are somewhat delicate and especially susceptible to damp. This continues until they have passed from the care of the hen, when they appear—like the turkey—to attain considerable vigour. It is customary to keep them for the first few weeks in confined runs, but after that they can wander about, and will not need much feeding. During the whole period, however, they want a fair proportion of animal food, and must have abundant green stuff. Under suitable conditions they obtain this for themselves. They do not attain a very large size, generally ranging about 3½ lb.; the bones are small and fine, and the flesh abundant. These birds are chiefly in demand about February and early March, coming between the game and chicken seasons, and at that period the prices realized are from 6*s.* to 7*s.* per couple. It is improbable that this class of poultry will increase to any great extent, as the demand is somewhat limited. [E. B.]

Guinea Pig. — The domesticated Guinea Pig or Cavy (*Cavia cobaya* or *porcellus*) is one of the smaller members of a family of South American rodents, the Caviidæ, characterized by somewhat ungulate-like limbs, comparatively

short incisor teeth, molars divided into lobes by folds of enamel, a very narrow palate, and a large cæcum. The upper lip is not cleft, the clavicles are imperfect, and the tail is rudimentary or absent. The Restless Cavy (*Cavia aperea*) is the nearest relative of the domesticated form, and is presumably the original from which it is derived. It abounds in La Plata in particular, but its range extends through Bolivia and Brazil. It makes a burrow in dry ground, but is more often found among plants in moist places, at the edge of the forest, or on the river banks. The tail is absent, the limbs are shorter than in the other genera; digit 5 is absent from the fore foot; digits 1 and 5 are absent on the hind feet; the nails are broad; the molars are divided into two angular lobes. The domesticated form is sometimes classed as a separate species, *C. cobaya*. The name 'guinea' is usually regarded as a corruption of 'Guiana'.

The guinea pig is a 'show' animal, and much attention is paid to breeding and rearing it.



Guinea Pig

Fanciers distinguish three main classes: the Peruvian Cavy, which has a coat of extraordinarily long and silky hair; the Abyssinian or Rough-coated Cavy; and the Bolivian, English, or Smooth Cavy. The first class is the least frequently reared, as it is more delicate than the others and requires a considerable amount of space. The hutches must be kept within a covered shed or other building, and each animal must have a separate hutch because of their habit of nibbling at each other's fur. The most scrupulous care must be taken to keep them supplied with clean, dry bedding, preferably of fairly long straw, which will not stain the hair. Their coats must be brushed out daily to prevent matting of the hair. They keep in good condition on fairly dry bread and milk, oats, and abundance of green food, with very little water.

The other classes require similar treatment, but are less sensitive to cold, and need not be kept singly. The rough 'rosetted' look of the coat is the special feature aimed at in the second class, and purity of colour is the chief desideratum in the third. An account of the different 'points' of each class, and the necessary treatment in rearing for show purposes, will be found in C. H. Lane's Rabbits, Cats, and Cavies (Dent, London, 1903). The average period of gestation in the cavy is sixty-three to sixty-six days. The young begin to feed on their own account in about a month, and are sexually mature within three months. Two to four young are produced at a litter, and there may be several litters in a year. Its great fertility, the comparatively low development of its nervous system, and its susceptibility to toxins have combined to make the guinea pig the most frequent subject of experiment in the investigation of problems of heredity and disease. [J. A. T.]

Gulls (Laridæ).—These web-footed swimmers are predominatingly coast forms, but the Common Gull (*Larus canus*), Herring Gull (*L. argentatus*), and Black-headed, or rather Brown-headed, Gull (*L. ridibundus*) wander long distances inland during winter and spring, and are therefore of some agricultural interest. As they follow the plough, and account for large numbers of larvæ, grubs, and pupæ, they may be regarded as decidedly beneficial, and deserve protection from the wanton destruction to which they are often exposed. It is true that both the Common and Herring Gulls sometimes take grain, and at times they destroy young turnips, but such depredations are only occasional and of minor importance. On the other hand, there are two species which do mischief in various ways—*i.e.* the Lesser Black-backed Gull (*L. fuscus*) and the Greater Black-backed Gull (*L. marinus*). The former does some harm to game, and the latter is reputed to attack sickly lambs and sheep. These two species are readily distinguished from the beneficial ones by the decidedly dark colour of their backs. [J. R. A. D.]

Gumming or **Gummosis.**—This diseased condition is recognized by the formation of abnormal quantities of a gummy fluid, which generally exudes through some wound and hardens outside the plant. It has been seen on cultivated plants of the Prunus family (Peach, Cherry, &c.), also on the grape vine, olive, mulberry, fig, and other fruit trees; a somewhat similar disease occurs on potato, turnip, beetroot, and other vegetables. The gum generally results from degeneration of cell walls, which, after being formed, begin to be dissolved again and converted into gum. Cavities are thus formed, branches no longer transport water and so dry up. Gum formation frequently follows wounding, and it may occur with stem canker of trees. Bacteria and fungi are sometimes present, but whether they actually cause the formation of gum is doubtful. Plants in a healthy condition naturally form gummy substances, and gumming is probably this action aggravated into a disease by pruning, over-cropping, and defects in soil condition. See also 'Gummosis' in CHERRY—PARASITIC FUNGI, 'Slime Flux' in ELM—PARASITIC FUNGI, and SILVER FIR—PARASITIC FUNGI. [W. G. S.]

Gums and Resins.—Vegetable gums and resins are exudations from plants. They either harden by exposure to the air or remain moist or even in a liquid state, and in that case are called *oleo-resins*. They are all compounds of carbon, hydrogen, and oxygen, and have the character of acids or anhydrides, which are capable of combination with alkalis. The oleo-resins are simply resins dissolved in a hydrocarbon, and the best example is perhaps common turpentine. This is found flowing from the barks of certain pines, the discharge being

increased through special treatment. When distilled, the hydrocarbon is separated as oil of turpentine, and the rosin (colophony), which remains behind, is perhaps the best known of all resins. *Resins* are soluble in alcohol, ether, benzol, &c., but insoluble in water; conversely, *gums* are soluble in water (or at all events are readily acted on by water) but insoluble in alcohol. The degree of solubility in water is, in fact, an all-important feature in estimating the merit of the true gums. Resins may, however, be found mixed naturally with gums, the substance being then spoken of as a *gum-resin*; when mixed with benzoic acid, or any of its congeners, they are *balsams*.

In trade it is customary to speak of all the above groups of products under the generic name of 'gums', notwithstanding their diversity both in chemical composition and industrial application. Nothing could, however, be more disastrous than to send into market deliberate or careless mixtures of gums and resins, or even mixtures of two or more gums or of two or more resins. Purity is an essential element of success. The following are the more important gums and resins:—

1. Gum Arabic or Gum Acacia.—The former name would imply that it comes from Arabia. It seems likely that it may, in ancient times, have reached Europe through that country, or simply have been procured from Arab traders. The chief supply to-day neither comes from Arabia nor is obtained from *Acacia arabica.* It is procured from Kordofan on the east, and Senegal on the west side of Africa, and is the produce of *A. Senegal.* The gum appears on the stems and branches during the prevalence of dry desert winds, which blow in winter after the close of the rainy season, and the flow is aided by certain methods of treatment. To a large extent the superiority of the Kordofan gum is a consequence of the environment allowing of the growth of but one species of gum-yielding tree over a considerable tract of country. In other localities the merit of certain gums is greatly lowered through the inferior grade of other equally abundant gums with which they are regularly and almost unavoidably mixed. Gum arabic is odourless and tasteless, but quite soluble in water, the best qualities taking one-and-a-half times their weight of water to form a thick, viscid mucilage.

The inferior qualities of gum arabic best known to trade are Suakim, Talca or Tahla, derived from *A. stenocarpa*; the Morocco, Mogador, Brown Barbary, and East Indian from *A. arabica*; Cape from *A. horrida*; and Australian or Wattle from *A. pycnantha*, *A. decurrens*, and *A. dealbata*. The so-called 'East Indian gum arabic' is imported into Bombay in the first instance from Aden and Red Sea ports, then picked, assorted, and re-exported—no portion is the produce of India. Indian gum arabic is best known in trade as 'gum ghati', and is mostly derived from various trees, the least important very possibly being *A. arabica*. The better grades come from Baluchistan, and are locally known as *khor* (*A. Senegal*) and *hurbarbara* (*A. Jacquemontii*). A very large assortment of soluble and edible gums might be given as substitutes for gum arabic, used locally but only rarely exported. Thus, for example, the gums of *Acacia Catechu*, *A. leucophlæa*, *A. modesta*, *Anogeissus latifolia*, *Buchanania latifolia*, *Boswellia serrata*, and of *Odina Wodier* are all so used, and the varying merits turn on their degree of solubility, colour, and purity. The imports of true gum arabic taken by the United Kingdom in 1907 were 91,017 cwt., valued at £137,915, of which fully one-third came from Egypt.

2. Gum Tragacanth—often spoken of as a *pseudo-gum*—is representative of a second great group of gums. It is obtained from three or four species of *Astragalus*, of which *A. gummifera* may be accepted as the most important. They are spiny shrubs found wild on the mountains of Asia Minor, Persia, Syria, and Greece. The gum, which exudes from cracks on the bark, may be described as a mucilaginous substance which arises from a more or less complete transformation of the cells of the pith and the medullary rays of the stem. The commonest forms are collected from natural cracks; the finer from special incisions made on the bark, such, for example, as Flake or Leaf and Vermicelli or Pipe Tragacanth. The better qualities may be described as dull-greyish in colour, without odour or taste. When placed in cold water they are seen not to be dissolved but to swell up into a gelatinous mass, and when boiled to form a jelly. Tragacanth is, however, readily dissolved in alkaline fluids, but, of course, is unaffected by alcohol. It is largely used in medicine, in confectionery, in stiffening, glazing, and facing certain fabrics, and in thickening the pigments used in calico printing.

An important group of gums are known as Tragacanth substitutes, or Bassora or Hog-gums. These are in India designated *kattra* gums. They much resemble the true tragacanth, but are inferior both in colour and purity, most of them containing a fairly large percentage of soluble gum mixed with the jelly-forming ingredient.

3. Resins.—In trade returns the only product of this nature that is separately recorded is the Kowrie (kauri, cowdee, &c.) or Dammar of New Zealand. In 1907 the United Kingdom took 137,697 cwt., valued at £480,795, practically the whole of which came from New Zealand. It may therefore be accepted as the true kowrie or resin-dammar, which is obtained from one or two species of pine (*Agathis australis*) found in the Northern Island, but formerly more extensively distributed. The dammar exists as a semi-fossil product, being dug out of the ground. Fresh resin obtained from living trees is known in trade as 'young kowrie'. The best quality is spoken of as 'dial', and is of a pale-amber colour to brown, of a glassy or opaline lustre, and fragrant odour.

Other dammars may be mentioned, such as (1) 'East Indian' or 'Singapore' or 'White', obtained from *A. orientalis*—the Amboyna Pine—a native of Malacca, Borneo, Java, Sumatra, &c. (2) 'Sal Dammar' or *ral*, the stalactitic resin of *Shorea robusta*. (3) 'Black Dammar' or the resin of *Canarium strictum*. (4) 'Rock Dammar',

derived from *Hopea odorata* in Burma, and *H. micrantha* in Malacca, Borneo, Sumatra, &c. (5) 'White Dammar or Dhup-resin'—the resin of *Vateria indica*.

All qualities of dammar are largely used in the manufacture of varnishes, but other varnish materials may be here mentioned, such as:— *Amber*—the finest and most durable of all this class of varnishes. It is a fossil resin found in Cretaceous beds in a narrow belt from England through Holland to Germany, Russia, South Siberia to North America. *Animi*, another fossil resin, comes from Zanzibar. *Copal*, a name often used almost generically for most varnish resins, is best restricted to 'gum copal' procured from West Africa; Sierra Leone copal; Angola copal; Loango copal, and Demerara copal. Lastly, to this long list of resins has to be added common *Rosin* or *Colophony*, already mentioned. American resin is of a darker colour than the European; the presence of water causes the rosin to become almost white. Although rosin is used in the manufacture of varnishes, it is even more valuable in soldering as a protective coating; and in the manufacture of rosin spirit and rosin oil.

4. Other Gums and Resins. — A long list would have to be given before even the most elementary conception was conveyed of the diversity of properties and uses of the products that fall into this position. In the trade returns of the United Kingdom, for example, mention is made of the imports of 'unenumerated' gums and resins having been in 1907, 237,974 cwt., valued at £632,700. The most important single producing country is the Straits Settlements and Dependencies, which in the year in question contributed 91,357 cwt., valued at £178,206, and the Netherlands, India, 48,008 cwt., valued at £76,615. It is perhaps safe to assume a fair proportion of these unenumerated products being very frequently the Dammars above briefly indicated. From Persia and India usually come smaller contributions, but these very possibly are the gum resins gamboge, asafœtida, bdellium, and benzoin, as also the oleo-resins and balsams, such as wood-oil, Burmese lacquer, &c.

Lastly, it seems necessary, in concluding this account of the gums and resins, to allude to the animal resin, lac or shell-lac. The imports into the United Kingdom in 1907 of that substance came to 116,856 cwt., valued at £1,074,602 —exclusively (or very nearly so) from India. See under Lac. [G. W.]

Gum Tree. See Eucalyptus.

Gun Licences. See Licences.

Guns.—Although shooting may be regarded as a form of recreation merely, there are circumstances under which a gun may be made to render useful service on the farm. In some districts, for example, rabbits abound to such an extent as to be a positive pest and a serious menace to agricultural crops. It is often requisitioned also when rooks, crows, wood pigeons, &c., work havoc among the brairds in spring, while the depredations of sparrows among cereal crops at harvest may be somewhat curtailed by a few charges of hail among the ranks of the marauders. Whether for purposes of sport or for more utilitarian ends, the gun is not infrequently regarded as a necessary part of the farmer's equipment. The technical details of the manufacture of guns concern only the expert and the professional sportsman and are not dwelt upon here, the object of the present article being rather to put the tyro in possession of such facts regarding guns as are likely to be of service to him.

The barrel may be either of one of the many brands of steel which have been devised for the purpose, or it may consist of specially prepared gun iron. Different combinations of metal and methods of handling in the process of welding are employed to produce various figured patterns in the finished barrel. Damascus, stub twist, and laminated steel are well-known types of welded barrel. The welded barrel adds to the beauty and finish of a gun; but so far as shooting qualities are concerned it does not offer any particular advantage over the plain steel barrel, which indeed is harder, and consequently is less liable to injury when accidentally dropped, or to become honeycombed by the corrosive action

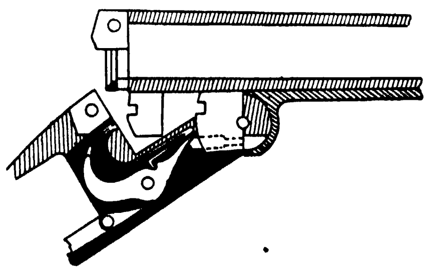


Fig. 1.—Greener's Hammerless Mechanism

of the powder. In modern guns the barrel is constricted at or near the muzzle, in order to concentrate the hail and increase its range and velocity. The method by which this is attained is known as 'choke-boring'.

The butt of walnut wood which is brought to the shoulder in the act of shooting is termed the stock. The barrels are opened and closed at the breech by a knuckle joint, consisting of several parts known collectively as the breech mechanism, and including a body piece with its accompanying bolts, to which are attached the barrels and the stock, and the levers and springs which actuate the bolts. The top lever is most suitable for ordinary sporting guns. The fore-part is a detachable piece lying under the barrels and forming part of the joint on which the barrels hinge. It rests on the left hand when aim is being taken at an object. The lock mechanism comprises all the parts necessary in the firing of the gun, which is done by a blow delivered on the percussion cap in the base of the cartridge. In hammerless guns the striker and its accompanying mechanism are wholly within the lock. Modern types of guns have a 'snap' action, *i.e.* the bolts which secure the barrels in position after loading engage automatically. They have also an ejecting mechanism by which the cartridge cases are thrown out when the gun is opened after firing, and withdrawing them a little if loaded but not fired.

Guns are made in various sizes according to the purpose which they are intended to serve. For all-round sporting purposes, the 12-bore gun with 30 in. barrels and weighing from 6¾ to 7½ lb. is perhaps most suitable. A gun of this description will fire a charge of 3¼ to 3½ dr. powder and 1⅛ to 1¼ oz. shot. The English pigeon-shooting clubs allow a gun of 8 lb., with a charge of 4 dr. and 1¼ oz., but the bore must not be greater than 12. Spherical bullets may be discharged from the ordinary double-barrelled gun even if choked, but the bullet must pass easily through the part of greatest restriction. In firing bullets from a 12-bore cylinder the same charge of powder may be used, and it should be secured with one card and one thick felt wad, with a winged field cloth wad over the felt on which the bullet is fixed. No further wad should be inserted on top of the bullet. The recoil when such a charge is fired is considerable. Smaller bore guns, 16, 20, &c., are not much in favour, and it is sometimes difficult

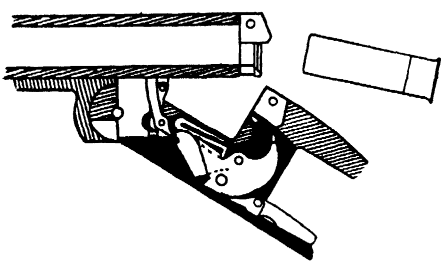


Fig. 2.—Greener's Ejecting Mechanism

to procure cartridges for them. The 16-bore is, however, equal to the larger 12-bore in strength of shooting, but of course its killing circle is less. One advantage of small-bore guns is their lightness.

In choosing a gun, quality of workmanship should always have first consideration, and where an inexpensive gun is desired it is preferable to select a gun of good quality, even should it lack the latest improvements and mechanism. A hammerless ejecting gun of inferior workmanship will certainly give less satisfaction in the long run than one of the old-fashioned pattern of sound and reliable construction. In fact, low-priced guns by good makers, even if of a superseded pattern, often prove quite satisfactory in use, and are well calculated to serve the needs of the farmer and occasional sportsman. The hammers should, however, be well under the line of sight when at full cock.

A few simple directions, if carefully observed, will go far towards maintaining a gun in good condition and prolonging its usefulness. It is important that the gun should be kept dry when not in use, and it should always be carefully cleaned before laying aside. The proper method of cleaning a gun is to place the muzzle downwards on a rest, and first remove the fouling by working the cleaning rod up and down several times, after which a flannel rag soaked in sperm or Rangoon oil or vaseline should be pulled through. The working parts should also be wiped with a piece of oily flannel, then with a clean, dry cloth before applying neatsfoot oil or other lubricant. Should the barrels become rusted, it is recommended that they be well scalded with boiling water, and afterwards thoroughly dried and oiled as before. In handling a gun, care should be taken in opening the barrels not to allow them to fall back with a jerk, and to close them again with due care. It is well to remember also that ejector guns will fail to throw out the cartridges if opened with too violent a jerk.

The reader should also consult the arts. on Cartridges and Shooting. The following are standard and up-to-date books on guns, and are recommended to readers desiring a fuller account of their mechanism: The Gun and its Development, which is the most comprehensive work on the subject, and The Breechloader, both by W. W. Greener.

Gutta Percha. See Caoutchouc.

Gutter.—The principal item under this head that the agriculturist has to do with is the 'grip' or urine channel of the byre. The similar channel in the stable receives less attention. In the byre there is of course much more liquid matter to be dealt with, and as the state of cleanliness within this building depends a great deal on the quickness with which the fluid stuff can escape, it naturally follows that the grip is worthy of some trouble in its construction. An effective grip is one about 21 in. in breadth, 6 in. deep next to the lairs of the cows, and 4 in. at the other side—that next to the passage behind the cows, the bottom dipping to the latter side with a fall of 2 in. In a grip formed in this way the urine is free to gain the clear side of the channel and make its way to the outlet without much hindrance. The semi-solid excrements are dropped into the side of the grip as the animals stand, and lie there without blocking up the channel, which is apt to be the case where the bottom of the same is level in cross section, or dips the contrary way to that we have indicated. Longitudinally the grip must of course have sufficient run to clear itself easily of fluid matter. Bottom and sides must be smooth if they are to offer the minimum obstruction to flowing matter. This condition, as well as the advantageous one of complete continuity of surface, is afforded by the use of Portland cement concrete in the construction of the grip. A grip of this sort can be effectively cleaned with little effort compared with what one has to expend over one paved with kidney stones or with flags. One course of scraper and brush leaves but little stuff for the flushing water (a bucketful or two) to shift. With regard to road gutters see Roads. Eaves gutters are referred to under head of Eaves.

[R. H.]

Gynerium, a genus of coarse-growing grasses, the best known of which is the Pampas Grass, *G. argenteum*, a native of the plains of South America. It was introduced into English gardens in 1848, where it has proved to be quite hardy, forming noble tufts, 6 ft. or more high, of glaucous green, gracefully curved leaves, and developing in autumn tall panicles of silky

white flowers. The leaves die in winter, but the rootstock is perennial. There are several varieties. The plant grows well in any soil and aspect, but is happiest in a sunny position and a wettish soil. Another name for the genus is Cortaderia. [W. W.]

Gypsophila, a genus of Caryophyllaceæ, comprising both annual and perennial species, natives of Europe and Asia. Some of them are grown in gardens for their loose elegant panicles of small flowers, the best being *G. cerastioides*, which grows a yard high and has white flowers; *G. paniculata*, also white; *G. fastigiata*, red-flowered; *G. repens*, 6 in. high, pale-pink, and *G. elegans*, a useful annual 18 in. high. The plants are grown chiefly for a supply of feathery sprays to mix with larger flowers. They all grow well in ordinary soil, and are easily propagated from division or seeds. [W. W.]

Gypsum.—Calcium sulphate in nature commonly combines with water and crystallizes as the mineral gypsum (or selenite), $CaSO_4 + 2H_2O$. Gypsum is colourless or white, is transparent in good crystals, and can be scratched with the thumbnail. Calcite is too hard to be thus scratched; the specific gravity of calcite, moreover, is 2·72, that of gypsum being 2·32. In its massive state, gypsum forms the rock *alabaster*. Gypsum is soluble in about 450 parts of water, and considerable deposits of it arise in desert areas on the drying up of lakes. Bands and massive beds of gypsum thus occur among the deposits of the Great Salt Lake of Utah, and in European Permian and Triassic strata, often associated with rock salt, which is precipitated at a later stage than the gypsum during the evaporation of the water. Gypsum is valuable as the source of plaster of Paris. The alkali soils of the United States have been ameliorated by the addition of gypsum, which converts the harmful sodium carbonate present into a sulphate. 0·1 per cent of sodium carbonate in a soil kills the seedlings of most crops; but to neutralize this in soil a foot deep 6400 lb. of gypsum per acre are required, and the cost in such a case is usually too great as compared with that of the alternative remedy, efficient irrigation. Gypsum is also used (in America under the name of *land plaster*) as a manure for ordinary loams. [G. A. J. C.]

In this country gypsum is not used directly as a manure, but a great deal is applied to the soil in the form of superphosphate. Superphosphate always contains a large amount of gypsum (see SUPERPHOSPHATE). Indeed there is always a larger percentage of gypsum than of soluble phosphate present in superphosphate. The setting of superphosphate during its manufacture is largely due to the formation of gypsum. As superphosphate enters largely into the composition of mixed manures, the users of such manures also apply gypsum to the soil. The result is that though gypsum is not ostensibly used as a manure in this country, great quantities are applied to the soil as a constituent of other manures. Possibly part of the beneficial effects of manures containing soluble phosphates is due to the gypsum which they contain, though the results are usually ascribed to the soluble phosphates only.

Another purpose for which powdered gypsum has been recommended is to prevent the loss of nitrogen from farmyard manure (see FARMYARD MANURE). It has been recommended that from 1 to 2 lb. of gypsum per beast per day should be spread over the excrements, and this plan has been followed in some places. The idea is that the gypsum will cause the volatile ammonium carbonate of the dung to be turned into non-volatile ammonium sulphate, and so prevent the loss of ammonia into the air by volatilization. This method of saving ammonia cannot be recommended. It appears to be based on a misapprehension of what takes place when gypsum and ammonium carbonate are mixed. All recent experiments on the subject show that even when considerable amounts of gypsum are used, no appreciable saving of ammonia results. Certainly the cost of the gypsum is not repaid in the increased value of the dung. [J. H.]

H

Habits and Instincts. — It is usual to apply the word 'habits' in a loose way to the everyday behaviour of animals. We can classify this behaviour according to its *objective* nature —as food-getting, food-storing, making shelters and homes, finding mates, preparing for the young, feeding and otherwise caring for the young, avoiding danger, playing, taking part in the social relations of the flock or herd, and so on. In a general way, it may be said that animals have only two occupations — caring for themselves (in feeding, self-protection, and adjustment to physical surroundings) and caring for their offspring. 'Every important thing to be seen about an animal', it has been said, 'has to do with one or other of these pursuits.'

But we have also to try to classify animal behaviour according to its *subjective* nature. It may be intelligent or non-intelligent; it may be controlled at every step or it may be habitual; and so on. Everyone knows that it is extremely difficult to decide how we should describe certain activities of animals. We have to avoid, on the one hand, the fallacy of crediting animals with faculties which they do not possess; we have to avoid, on the other hand, giving a false simplicity to the facts of the case. We must not read the man into the beast, and we must not reduce the animal to the level of an automatic machine. The practical rule is to try to redescribe the observed activity in as simple terms as possible without leaving out any essential feature. The terms used in our redescription will indicate the group in which the observed

behaviour should be ranked. When a cow flicks a fly off her side with her tail we cannot call this an intelligent action, for we know that similar acts can be performed by animals whose brain has been separated from the spinal cord. When a collie rises to an unexpected situation, adjusting its behaviour to a more or less novel crisis, we need not call it rational, and we cannot call it instinctive. It is certainly intelligent.

It is usual to recognize an inclined plane of activities, and a common mode of arrangement may be outlined. (1) Inside the body many effective activities go on 'of themselves', such as the beating of the heart, and these may be called *automatic internal activities*. (2) Many an action follows unfailingly on the application of an external stimulus, without requiring thought (as we know from our own experience), without requiring the higher (cerebral) nerve-centres (as we know by experiment.) These are simple reflex actions, such as swallowing, sneezing, coughing, twitching the skin when a fly lights on it, shutting the eye when a branch is about to strike it. (3) When numerous actions of this simple sort are linked together in a definite sequence, we have to do with compound reflexes, as in sucking, or chewing the cud. (4) Many animal activities are exhibited in striking perfection by young inexperienced creatures; they seem to be independent of the individual's experience or education, though they may be improved by both; they seem to be due to an inborn capacity, to what might be called a ready-made habit if that were not a contradiction in terms. These puzzling activities are called instinctive, and familiar illustrations may be found in the bees building their comb, the spiders spinning their webs, the birds uttering a characteristic cry or migrating, the dormouse retreating into winter quarters for its long sleep. Professor Lloyd Morgan in his authoritative work, Habit and Instinct (1896), gives the definition of instincts. 'From the biological point of view instincts are congenital, adaptive, and co-ordinated activities of relative complexity, and involving the behaviour of the organism as a whole. They are not characteristic of individuals as such, but are similarly performed by all like members of the same more or less restricted group, under circumstances which are either of frequent recurrence or are vitally essential to the continuance of the race. While they are, broadly speaking, constant in character, they are subject to variation analogous to that found in organic structures. They are often periodic in development and serial in character. They are to be distinguished from habits which owe their definiteness to individual acquisition and the repetition of individual performance.' (5) 'A habit is a more or less definite mode of procedure or kind of behaviour which has been acquired by the individual, and has become, so to speak, stereotyped through repetition.' In the strict sense, a habit is individually acquired as the result of the frequent repetition of what at first demanded attention and control. A trick of gesture, a peculiar mode of locomotion, a routine of behaviour that required long training, may become habitual. In habits as well as instincts there is automatism, but in the former it is acquired, in the latter it is congenital. There is no clear evidence that habits are ever transmitted as such from parents to offspring, but instincts are inborn. There seems very little in favour of the old view that instincts have arisen from habits which were at first intelligent. (6) When the animal's behaviour shows effective adjustment to novel conditions, when it cannot be redescribed without supposing that the animal made an inference, we call it intelligent. (7) When the behaviour rises into conduct controlled in relation to general ideas, when the inference is on a higher plane than 'putting two and two together', 'when it is conceptual, not perceptual inference', then we must use the word rational; but this term should probably be kept exclusively for the higher reaches of human conduct.

Brief reference may be made to a few common errors. Of the animal's behaviour it is often said 'It's all instinct'. This is quite inadmissible in the case of many birds and mammals, where there is obvious intelligence. Even in animals like ants and bees, where the behaviour is largely instinctive, there is probably more intelligence than is often supposed. If we could get nearer them individually, if we had a more intimate knowledge of their detailed ways, we should perhaps discover many intelligent departures from the routine of instinct, just as we discover among ourselves many intelligent departures from the routine of habit. Animals may sometimes be cleverer than they seem. The opposite error is to estimate the mental process of the animal by the beautiful finish and perfect effectiveness of its behaviour. In their instinctive behaviour, animals are not so clever as they seem. The common recoil from the biologist's assertion that neither horse nor dog has 'reason' is a misunderstanding of the distinction—a question of definition—between 'reason' and 'intelligence'.

Much has yet to be done in the way of precise study of the habits and instincts of domesticated animals. There is very little information of a definite kind on the formation of a new habit in dog or cat, in horse or cow. An exceedingly interesting enquiry is that which has been well begun by Dr. Louis Robinson in his Wild Traits in Tame Animals (1897),—an enquiry into those modes of behaviour which seem to be survivals of the original wild life. It was in the pack that the dog learned to signal by its tail, to guard its bone, to obey orders, to watch, and so on. As Darwin suggested, the turning round and round on the hearth rug may be connected with the primitive roving of the pack, which moved from place to place and found temporary resting places for the night among the long grass. The crime of sheep-worrying is a recrudescence of old ways. Shying in horses may be in part a relic of a valuable ancestral instinct to swerve suddenly from suspicious movements of snake or wild boar or crouching tiger among the bushes and reeds. Wild foals run with their mothers, and unto this day foals do not gorge themselves with milk as calves do. Scotch cattle taken to a large American ranch hid their

calves among the thick herbage, true to the old ways, for the wild cows hide their young in the thickets while they go to graze in the open. The angry ewe still stamps her foot—the old signalling of danger on the mountain sides. We laugh at the sheep as they go in file and jump in succession over an imaginary obstacle simply because one of them did it by mistake, but they are acting in accordance with one of their oldest and most useful instincts. The pigs squeal now because their wild ancestors squealed to summon their neighbours to help them against a bear; they grunt now because it was by grunting that their ancestors kept together in the jungle or among the high brackens. This and that interpretation may be fallacious, but there is no doubt as to the profitable nature of the enquiry, which is not only intellectually interesting, but may lead to a better understanding of various modes of behaviour still very puzzling. [J. A. T.]

Hack.—'Hack' is the name given to a saddle horse—one which affords the rider a comfortable mount, which does not cause needless fatigue, is light in hand and well mannered. He may be smaller than a hunter and more breedy, or partaking of the blood horse, his action requiring to be easy rather than high. A small head and long tapering neck, oblique shoulder, and sloping pasterns are prized in a hack as the best conformation. A thick shoulder or short pasterns are incompatible with a comfortable hack, whose withers should be high, and chest deep rather than broad. There is no special breed of saddle horse in this country, but some of the best have been the produce of blood horses out of pony mares. The hackney with his high action is least likely of any breed to make a comfortable hack. [H. L.]

Hackle, an iron-toothed instrument used for sorting or pulling out hemp or flax. Hackle may also denote the 'fly' of the angler.

Hackney Horse.—The word 'Hackney' comes to us from the Normans. He has also been called Roadster, Cob, and Galloway or Galloway Nag. Although the Hackney has been a distinct breed for the past two hundred years, it is only within recent years that he has been generally recognized as such, and while the other names may still be applied to any cross-bred horse used for general purposes, it is understood now that when one uses the name 'Hackney', the pure-bred registered horse or a horse bred from registered stock is referred to.

Where did the Hackney come from? In a word, he is the survivor of the best strains of the general horse of all work, from the earliest development of the English horse down to the present day. This development had its ebbs and flows with the prosperity and adversity of the country. When peace and prosperity reigned, we find our people, rich and poor, following their different sports, the wealthy engaging in flat-racing as they do still, the humbler people going in for trotting, showing, &c. This was carried on by the best animals of each class, bred partly from our own old British horses, but no doubt mixed with some imported blood. This imported blood gradually increased from the beginning of the 17th century till Charles the Second resolved to form a royal stud, and instructed Sir John Fenwick to import a number of Arabian stallions and mares for that purpose. After that time a good many more Eastern horses were imported by private gentlemen, and by the end of Queen Anne's reign, 84 Arabs, 47 Barbs, 32 Turks, and 4 Persians had been brought into this country. The Eastern horses, crossed with our flat-racing mares, formed the foundation of our world-famed Thoroughbred; and in the same manner, crossed with our trotting mares, they laid the foundation of our now equally famed present-day Hackney, the breeders of the different classes selecting the imported horses they thought best suited for their different purposes; and it is to these Eastern horses that both Weatherby's Thoroughbred Stud Book (formed 1810) and the Hackney Stud Book trace back. The Darley Arabian and Leeds or Godolphin Arabian, both imported early in the 18th century, were most favoured for producing the general-purpose horse, and it was from them that Shales the Original was descended, being sired by Blaze, who was by Flying Childers, who was by the Darley Arabian from a granddaughter of Leeds Arabian. The dam of Shales was a useful trotting mare, likely to have been by an imported sire from one of our own English mares. That lays the foundation of our present-day Hackney, the date of the birth of Shales being 1755. From that foundation, Mr. Euren, about thirty years ago, undertook the task of gathering together a record of all the famous Hackneys, and formed the Hackney Stud Book, the first volume, published in 1884, containing 880 stallions, with 68 in appendix. Four hundred stallions and 398 mares, mostly by sires registered in the first volume, were entered in vol. ii, and this year (1908) vol. xxv is issued with a total number of 10,504 stallions and 19,692 mares, a membership of 2045, and a good balance standing to the credit of the Hackney Horse Society.

The Hackney is a short-limbed muscular little horse, the best and purest of the breed standing from 15 to 15·2 hands high, although by care and special attention they can be easily grown to 16 hands and over. His head is of medium size and fairly broad between the eyes; the eyes are bright and full, ears not too long, but very active, and the whole expression one of intelligence. The neck is fine and light as it approaches the head. The riding Hackney has deep well-laid shoulders, but the harness type has generally a squarer shoulder and an easier back. The quarter in the latter case is square, and the tail high set on, while in the former the quarters are not so straight, and the thighs more powerful. It is important that the Hackney carries his tail well up, walking and trotting; well-bred Hackneys universally have this merit. The legs are short and powerful, with large hocks and knees, and plenty of muscular power above and good flat bone below. His canon bones are short, pastern joints large and deep-set, pasterns not too long, but broad, powerful, and well set. Feet are of medium size, rather deep in the hoof than broad. There

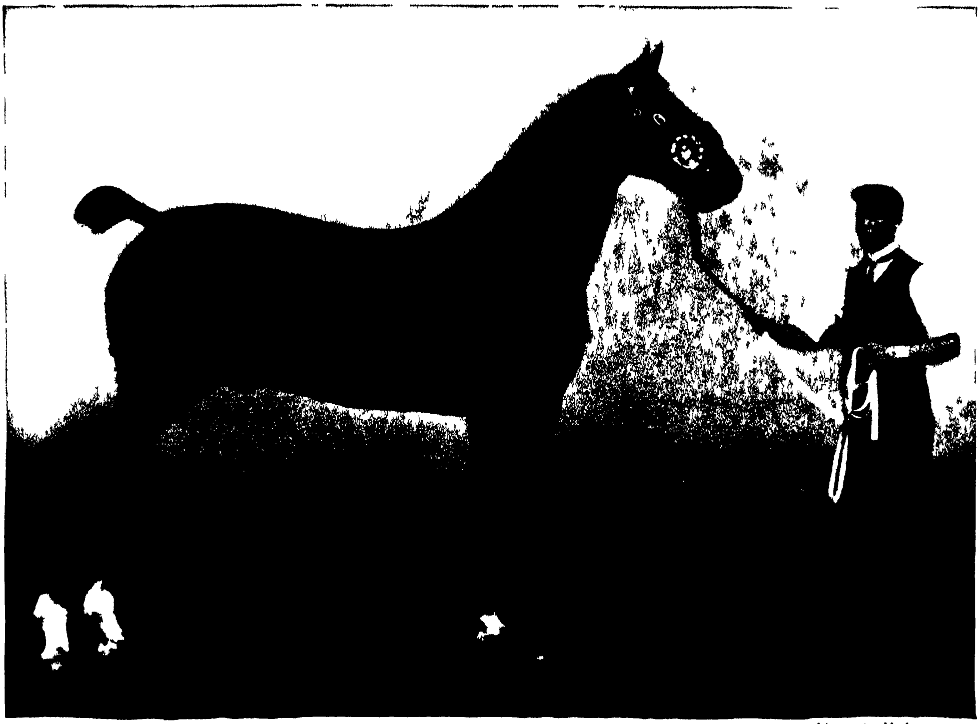


Photo G. H. Parsons

HACKNEY STALLION—"FLASH CADET"

1ST AND CHAMPION AT THE R.A.S.E. SHOW, 1908

Photo G. H. Parsons

HACKNEY MARE—"OPHELIA'S DAUGHTER GRACE"

1ST AT THE ROYAL LANCASHIRE SHOW, 1908

are all colours in Hackneys, very few greys, a fair quantity of bays, browns, and blacks, and about three-fourths of the whole, chestnuts, no doubt deriving this from the pure-bred Arabian chestnuts. These are some of the chief points to be looked for in the Hackney, but there is an electric fire about him that makes him the essence of all horses. From the tip of his ear to the last hair of his tail he is a model of symmetry and beauty. Quiet and affectionate in the stable, there is yet in his composition that something which at the merest word or touch can electrify him into the brightest of animals. It is this quality above all that makes the true Hackney so attractive; without it, they cannot walk or trot like a nag. It was this that in the good old days carried the English lords and squires to parliament, travelling sixty, eighty, or a hundred miles at a stretch. A nag, it was thought, could never be asked to do too much.

Since the days of Shales there have been, in every generation, great important horses—both sires and dams, descended direct from the pure-bred Arabian—that have kept up the standard of the breed; and we can never be grateful enough to these old Eastern masters for the trouble and care they took in preserving, for so many generations, an animal with such valuable power as to be able to create both the Thoroughbred and the Hackney. As already mentioned, the Hackney Stud Book practically commences with Blaze, the sire of Shales (foaled 1755), who was, according to the stud book, a pure-bred Eastern horse closely related to a mare known as Bright's Roan Mare. This mare must have had a considerable influence on the early Hackney breed, as we find a great many of them partook of her strong stamp and roan colour. She must also have had a great deal of the trotting quality in her veins, as we find the trotters about that period mostly descended from her, including Messenger, who was a direct descendant of Blaze, and who laid the foundation of the present American trotter.

Of Shales the Original, the real father of the Hackney, we have not much record, but in Norfolk and Lincoln we find that descendants of his were sold for as much as £150. Two of his produce stand out in prominence — Scot's Shales (692—vol. i), foaled about 1762, the sire of many noted horses, and Driver (187—vol. i), who was the sire of Jenkinson's Fireaway (201), a famous horse foaled about 1780, bright chestnut in colour, who was sire of Wroot's Pretender (596), who in turn was sire of the much-famed Ramsdale's Performer (547). It is to this famous old horse, Ramsdale's Performer, that many of the Norfolk and Yorkshire strains go back, and especially do the Yorkshire Hackneys owe much of their quality to him, as he was the sire of Black Rattler (82) and Lund's Merrylegs (449), two of the chief sires of this strain of Yorkshire Hackney. But yet another, and probably a stronger strain of breeding, came from the above-named Jenkinson's Fireaway (201)—the Bond's Norfolk Phenomenon strain — through West's Fireaway (203), who was grandsire to Wright and Gould's Norfolk Cob (475), the sire of Bond's Norfolk Phenomenon (522). This Norfolk Phenomenon was admitted by all trotting and hackney men of his day to be the most famous Hackney stallion in the history of the breed. The trotting and show chronicles of his day were filled with reports of him both as a trotting and a show horse, and there was nothing in the early part of the 18th century that could compare with him. One old record says of him: 'It will be allowed by all judges that he is the best and fastest trotter ever shown in any public market. From his superiority and muscular strength, his reach and rapidity of action, it is doubted whether there was ever a horse in England that could go with him.' He was foaled in 1824, was a red roan with black points, and stood 15·2. His dam was a trotting roan mare of the other line of Jenkinson's Fireaway, viz. Read's Fireaway (202) by Wroot's Pretender (596). This Norfolk Phenomenon blood was spread over all the hackney counties. Being reared in Norfolk, he laid the foundation of his stock there, and his fame soon becoming widespread, his owner, at a high price, was tempted to let him into Lincoln for a few years. Ultimately he became the property of Philip Ramsdale of Market Weighton, and stamped his type and character over all the most important part of Yorkshire, Achilles (2), Triffitt's Fireaway (249), and Burnham's Lord Derby II (417) all tracing back to him. He ended his days in Edinburgh in 1850, and was famous to the last for his fast trotting, which was the only quality in him that was appreciated in Scotland; and his owner, whom the writer met about twenty years ago, was still full of tales of his greatness. One cannot speak in too high terms of the value of this animal, and the farmers who were lucky in owning a few of his descendants during the boom of the 'eighties could get any money they liked to ask for them. Nine-tenths of the Hackneys we find round the Market Weighton district of Yorkshire are descended from those two animals of Ramsdale, viz. Ramsdale's Norfolk Phenomenon and Ramsdale's Performer, both of whom are bred down from Jenkinson's Fireaway (201). Ramsdale's Performer was the sire, through the dam's side, of Sir Charles (768), who sired Denmark (177), from whom came Danegelt (174), the sire of many noted horses of the present day; and on the other line from the same original Jenkinson's Fireaway, as has already been seen, come Achilles (2), Triffitt's Fireaway (249), Burnham's Lord Derby II (417), and through Bay President — a thoroughbred outcross — there comes Cook's Phenomenon (584), who, put to a Fireaway mare, produced the famous Wildfire (1224). We know now what the best of the present-day Hackneys are composed of. The meeting of these two important strains from Jenkinson's Fireaway has produced such animals as (1301) Ophelia, and many other noted matrons, and such sires as Rosador (4964), Garton Duke of Connaught (3009), Polonius (4931), His Majesty (2513), Royal Danegelt (5785), Mathias (6473) &c., and they are now principally responsible for the present standard of the Hackney horse.

It is impossible to give the name and description of all the Hackneys that are worthy of

mention, and all the breeders who might be named, but a perusal of the Hackney Stud Book will give the particulars of any strain, and the breeders, up to the present day. In the north of England and in Scotland we cannot refuse to the Norfolk people their dues in laying the foundation of the Hackney breed. There are many names handed down of men who, about the middle of the 18th century, developed and fostered the breed. We have records of them about 1730 immediately connecting their animals with the old Arabian blood. Jenkinson, Weatherill, Bond, Burgess, and Groot were chief among the breeders in Norfolk who passed down the stronger and more vigorous strains to Yorkshire in the beginning of the 19th century. These were picked up and selected by the Ramsdales of Market Weighton, who spread them among the principal horse-loving families in Yorkshire. Amongst those who took them up, and have been specially interested and successful in developing the breed to the present time, are — Francis and William Rickell of Warter, Pocklington; Francis Cook of Thixendale, J. P. Crompton of Lowthorpe, Richard Smith of Shipton, Henry Moore of Burn Butts, Arthur Fewson of Hedon, &c. John Robinson of Harrogate, late of Hull, has done perhaps as much as anyone to make the breed popular, although he himself is not a breeder. For upwards of forty years he has laboured early and late to make the most of these pure Hackneys in saddle and harness, and it is largely due to his efforts in showing what Hackneys are capable of doing that they have become so fashionable all over the world, particularly in the show ring.

After Norfolk and Yorkshire, it will not be too much to say that Scotland was the next country to take up the Hackney. Many years ago there was a horse brought into Scotland by the Douglas family which laid the foundation of a famous strain of trotting horses. Later, about 1840, there was an animal brought into Lanarkshire by the Duke of Hamilton, a bay-brown horse bought in Norfolk. Nothing is known of his breeding, but he must have been of a true Hackney family, as he filled the west of Scotland for many years with trotting Douglases. This was the only horse of any distinction in Scotland till about 1883, when Mr. Rutherford of Annan exhibited at the Highland Society's Show two famous mares just come from the hands of Mr. Robinson of Hull—Lady Patrington, a grey mare by Lord Derby II (417) out of Collingson's old grey Arab mare, and Warter Lily II, a chestnut by Denmark (177) out of Nelly, and bred by Rickell of Warter. These animals were much superior to any animal ever previously seen in Scotland, and within four weeks after the above-mentioned show there had been imported into Scotland from the Holderness district of Yorkshire a truckload of foals, nine or ten in number, and mostly sired by the famous Lord Derby II (417). This buying from Yorkshire was continued year after year by several Scotch fanciers, till very soon at the principal exhibitions all the prizes were won by these animals, so much so that in the 'nineties the different shows committees over Scotland considered it advisable to introduce classes for stallions, mares, and young stock of the Hackney breed, and the wisdom of this step is apparent by the great improvement in the general class of driving horse all over the country. The roadster, as the former horse of all work was called, is never now seen in the show yard, and is becoming a thing of the past.

The same evolution has since taken place all over England and Wales, and is rapidly spreading over the United States and the Continent of Europe. For several years, representatives from America have visited this country and taken away large numbers of our very best stallions and mares, and most of the principal trophies in the harness classes, open to all breeds, at New York, Philadelphia, and other important exhibitions, have been won for the last few years by Hackney horses. Buyers from Europe attend the Hackney show in London annually to purchase stallions to improve the breed of carriage horses in their respective countries, and many of the best foreign horses now imported into this country are by these Hackney stallions. Within the past few years many very fine Hackneys have also gone to the Argentine, and it is recognized in all countries that to get that exquisite grace, carriage, and action so requisite in the highest class harness horse, the Hackney has to be applied to.

Since the merits of the Hackney have become well-known and his fame world-wide, some large prices have been paid for the best specimens of the breed. The highest price, 5000 gs., was paid for Danegelt (174), perhaps the greatest sire of recent years. A grandson of Danegelt on both sire and dam's side, Hopwood Viceroy (9280), was sold to go to the Argentine in the summer of 1908) for the reported price of 4000 gs. Goldfinder VI (1791), also by Danegelt, was sold for 3000 gs. Cadet (1251), by Lord Derby II (417), cost 3000 gs. to a purchaser in the United States, and several other stallions have been sold at from 1000 to 3000 gs. Forest King, the champion harness horse, was sold to go to the United States for about 2000 gs., and is said to have been resold there at nearly double that figure; while the harness mare Menella, champion at the Hackney show in London, was sold by public auction in 1906 for 1175 gs., and a 14-hand Hackney pony stallion, Little Ruby, also by public auction in 1907 for 1025 gs. While these are exceptional prices, and are given for only the most outstanding animals of the breed, many good Hackneys are sold every year at from 100 to 500 gs. [A. M.]

Hackney Pony. — The Hackney Horse Society has been in existence for nearly thirty years, and it is within that time that the great development of the pony, with its high-stepping action, has been to any great extent evolved. No doubt Norfolk had for many years previously a breed of small horses, bred from Norfolk Hackneys in the male line, and doubtless descended in the female line from ponies bought at Norfolk fairs, and brought from the various pony-breeding districts by the jobbers and dealers who went round the fairs and markets

with droves and strings of horses prior to the days of the railway. We know, at any rate, from old reports of fairs, that in connection with them there were often trotting races, at which small animals, known as cobs, were matched together or against time. Showing in harness is a feature of much later date, and was founded as an attraction for the ordinary visitor of our present show system.

So far as we can gather, these small animals bred in Norfolk are nearly all given a dam or granddam as being Welsh, and no doubt droves of these hardy little Welsh animals were shown at the fairs in that and adjoining counties. At the first show of the Hackney Horse Society the first prize in the stallion class for ponies not exceeding 13·2 was won by Pomfret Wonder, and for cobs 13·2 to 14·2 by Lord Calthorpe's seventeen-year-old brown Don Carlos, by Tice's Prickwillow, out of a mare 'believed to be Welsh'. Pomfret Wonder and Don Carlos got many good pony mares which appear in pedigrees of to-day, but as sires of stallions they do not seem to have left any mark. Don Carlos' half-brother in the male line, D'Oyly's Confidence, however, for many years quite dominated the breeding of ponies in both male and female line, and to-day all the best sires go back to him. He was a dark-brown by Tice's Prickwillow, and his dam traced back to Bellfounder, the progenitor of the trotting horse in America to a great extent. This must have been a most prepotent sire of action, and when mated with Welsh and other pony blood 'nicked' to perfection. The Champion Sir Horace, through his sire Little Wonder 2nd, traces direct to him. Berkeley Model, Pomfret Wonder, Portwood Confidence, and in fact all the principal pony stallions of the past and present day, have the Confidence blood on one side or the other, more than one London winner having it on both sides, notably in Horace Junior, the beautiful pony bred by Mr. James M'Meeken, sired by Sir Horace, and out of a Confidence pony which went back to the female line of that good Hackney stallion, Gentleman John. Cassius is another sire which claims Confidence in his female line, and got the noted stallion Julius Cæsar 2nd. This pony was out of Sir Horace's full sister, and hence got another cross of Confidence in the female line. Sir George (Wilson's) is the only other pony stallion of former days that has left any mark in the Hackney pony world, and he principally in the female line. But before mentioning the influence of the females on pony breeding, we ought to mention Ruby, a Norfolk sire bred off Confidence lines, and which late in life was taken by Mr. Alexander Morton to Scotland, and has produced several prizewinning ponies, including Little Ruby, who again was indebted for much of his merit to his dam's line of breeding.

Thirty years or more ago Mr. C. W. Wilson made the Hackney pony what it is to-day, principally through his acquisition of Sir George and the very beautiful lot of mares which he got together to mate him to. The 'Wilson' ponies have a world-wide repute. They began with The Pet, a mare bought in Wales of a blood-like type, and without doubt crossed by Arab or Thoroughbred from a Welsh dam. She was the foundation of all the 'Snorer' family, a line of ponies that has proved in the female line unbeatable for years past. They are noted for their beautiful style, quality, and saddle shapes, and by inbreeding father to daughter, sometimes even grandfather to granddaughter, they have become fixed as the rocks to style and type, and can be known anywhere. Another family of like strong characteristics was the 'Georgina', bred originally from a racing Galloway which came from the north; from this a stout, fine-actioned pony has been developed, and this line wins everywhere, one after another London winner claiming descent from the family. Yet another was the 'Lady Kate' family, an original Westmorland Fell pony, from which descend such wonders as Tissington Kit Cat and others. Another very celebrated mare Mr. Wilson had was the marvellous pony mare Dorothy Derby, known all over as the dam of that wonderful sire Sir Horace. She was of an old pure Hackney strain, with no pony blood in her veins so far as can be traced; but her sire, Lord Derby 2nd, frequently sired a small-sized one, and when he did, it invariably reverts back to pony type, and what is more, when bred again to pony blood never reverts again to the larger size or loses its pony characteristics. Eventually nearly the whole of these four special lines of ponies came into Sir Gilbert Greenall's possession, and have been fostered and improved until now they stand almost by themselves, or aid considerably in the merits of other strains. Another mare which proved an excellent breeder of ponies was the late Mr. Day's Peggy Sure. She bred some fine-going stallions and one or two good mares when mated to Norfolk sires, especially to the big horse Leeds' Monarch, and her stock still now and again come to the front in our show yards. She was a very small pony, and could therefore be mated with large-sized horses; but to a pony she never bred anything of special merit, and most of her produce in the male line have disappeared. She traced back to Welsh blood. Those wonderful ponies, Pope's Magpie and her sister Movement, were of Confidence blood; doubtless on their female line, from their colour, descended from some foreign strain of small-sized horses, but with their long season of showing in harness they did nothing much to perpetuate their qualities, as Magpie's son, Magpie's Danegelt, is the only pony at service. He has been quite successful, although his sire's influence, Danegelt, makes his get somewhat unequal in size.

Scotchmen have always fostered the breeding of Hackney ponies, and of these Mr. Alexander Morton and Mr. James M'Meeken have done more than any others to keep together and improve this most beautiful breed of pony. Sir Gibbie, one of the most charming of small ponies ever seen, went to Mr. Morton from his breeder over thirty years ago, and it was not long before his dam was secured, a little low old-fashioned mare called Polly, by Triffit's Fireaway, which went back to a Welsh pony for her dam's foundation. She was mated to

Lord Derby 2nd, and produced Lady Ethel, a mare which has been the dam of perhaps more splendid ponies than any other line of mares, not excepting the 'Wilson' ponies. Mr. M'Meeken later acquired Polly, and put her to a son of Denmark and bred Merry Polly, which won London twice, and bred several winners. Polly bred other famous ponies for Mr. M'Meeken, and stayed with him until her death. Like the 'Wilson' ponies, the major portion of this family was acquired by Sir Gilbert Greenall, and he has won honours innumerable with the family when mated with the Champion Sir Horace and Goldfinder 6th. Mr. M'Meeken has never lost sight of the marvellous merit of this strain of pony, and he has time and again taken the opportunity to acquire good representatives of the family; and Mr. J. E. Kerr, in whose horse-breeding transactions Mr. M'Meeken is much interested, took first and champion at London in 1907 with Sir Archie, a pony stallion by Sir Gibbie (out of Polly) out of a Sir Horace mare, a granddaughter of Polly, so that this inbred sire should further demonstrate in Scotland the influence such a mare as Polly has had in the formation of a race of ponies unique almost in any one family.

The extraordinary development of action and pace without losing anything of the well-balanced style of going when in hand which the best specimens of the Hackney pony have when in harness, has made pony exhibiting one of the most attractive, pleasant, and profitable of the many hobbies connected with live stock. The show of ponies at the ring side always brings together the public from all parts of our show yards, and the merest novice cannot get far wrong in his admiration and criticism of the beautiful shapes and styles of the ponies now to be seen in harness. Sir Horace's stock are undoubtedly far in advance of other strains as prizewinners. No less than 151 of his sons and daughters have won prizes at the London Hackney Show alone within the past eight years (1901 to 1908), and so valuable have the prizes for harness become, and so universal at all shows, that many a grand pony colt has been altered to admit him to harness competition; but fortunately there are a few breeders in England, Scotland, and Wales that are careful to hold on to their female ponies, and are doing excellent work to foster and improve the stepping pony, so that there is no fear but that the future is assured, for there is now, and will be always, a good demand for the driving pony notwithstanding the bicycle and motor, which have in a measure usurped the usefulness of the larger harness horse for roadwork.

The improvement of the Welsh pony by the crossing of Hackney ponies was much developed by the late Mr. John Jones, of Colwyn Bay, and his son still continues on the same lines, and has further extended it by the acquisition of several of the Snorer family. Mr. Jones bred several London winners by his Julius Cæsar 2nd direct from Welsh mares. The Earl of Londonderry did much some years ago, and the experiments have been still further developed by the Seaham Harbour stud, under Mr. Brydon's supervision, to interbreed the Hackney po[illegible] with the Shetland, and some really fine poni[illegible] by that good pony Little Wonder 2nd has be[illegible] the result. The only other well-known sho[illegible] pony from a Shetland foundation was Pop[illegible] Fanny, unbeatable in harness for years. S[illegible] never bred, but a full sister of hers bred t[illegible] piebald Nena, a Royal and London winner, an[illegible] a mare whose descendants by Sir Horace an[illegible] Little Wonder 2nd have won premier honou[illegible] at London both in hand and harness. Mr. Ia[illegible] Ramsay in the Isle of Islay is also carrying o[illegible] a pony-breeding stud, and improving the breed of island ponies greatly. Mr. Martin Hadde[illegible] some years ago experimented with a pony stal[illegible] lion by Cassius out of a Snorer mare on Ex[illegible] moor mares, and he bred some beautiful ponies. They were, however, dispersed, and furthe[illegible] crosses I have lost sight of, although occasion[illegible] ally one figures in the prize lists of our shows.

Fourteen hands has always been the recog[illegible] nized pony height, and it appears to be quit[illegible] easy to keep to the size. Some breeders o[illegible] land unsuitable, or too good, have tried lat[illegible] foaling, early weaning, and other methods o[illegible] keeping down size, but they have invariabl[illegible] lost type and the vigorous pony constitution and it is better to try some other breed in suc[illegible] districts. Given suitable environment, mare[illegible] small and stallions full height, foal when ther[illegible] is grass, treat well but not lavishly first winte[illegible] of their lives, and no fear but the result will b[illegible] a thoroughly sound and satisfactory pony, i[illegible] rightly bred in the first instance.

When matured, the well-bred Hackney pon[illegible] is a marvel of endurance, docility, and courage beautiful to look at, useful for all purposes fo[illegible] which his size qualifies him in the equine world long of life, sound in limb and constitution, and worthy of the kindest and most careful attention that can be given, and which he will fully repay whether to keep or sell is the object of the owner.

Sufficient material exists to continue the lines of ponies derived from Welsh, Westmorland Fells, Shetland, or Exmoor foundation, so that much of the 'spade work' done by others in past years can be at once taken advantage of.

[W. BA.]

Hæmatite is a heavy mineral composed of ferric oxide, Fe_2O_3, and is one of the richest ores of iron. It usually occurs in kidney-shaped or mammillated forms, with a radial fibrous structure when broken. In its compact type it has a dark grey-purple colour, inclining to red; its powder is purple-red, and the name 'hæmatite' refers to this blood-red tint. The surfaces of nodules of hæmatite are commonly reddish, and the mineral weathers ultimately into the hydrated iron ore, limonite. In some soils, however, in warm climates, the reverse process takes place, and the alteration and oxidation of iron compounds results in the formation of intensely red and hæmatitic deposits. [G. A. J. C.]

Hæmatopinus, a genus of the Anoplura or true lice, to which most of the species infesting domesticated animals belong. They have five-jointed antennæ, and the thorax is narrower than the abdomen.

Photo G H Parsons

HACKNEY PONY STALLION "WHITEGATE SWELL"

1ST AT THE R.A.S.E. SHOW 1900

Photo G H Parsons

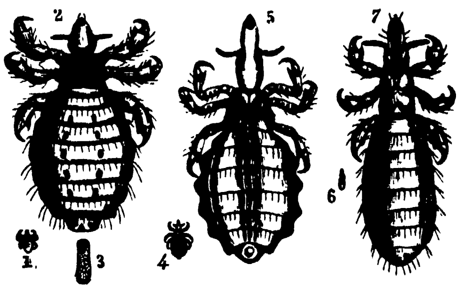
HACKNEY PONY MARE—"FYLDE CLASSIC"

WINNER OF NUMEROUS PRIZES

H. eurysternus (fig. 1, the insect natural size, 2 magnified), the Ox Louse, is flat, and of a chestnut colour, with an oval head, a somewhat quadrate, brown trunk, and a large, oval, dirty-white body, with two rows of spots down the back. The six stout legs have strong claws, tipped with black, adapted for clinging to hairs. Fig. 3 shows one of the eggs or nits magnified.

H. urius (the Swine Louse) is frequently abundant on ill-conditioned herds of imported pigs. It is of a rust colour; the head is very long, the trunk broader; body dirty-white, the spiracles surrounded with black; the legs are pale ochreous, the thighs banded with brown; extremity of the shanks dark, toothed internally at the apex; claws long and black: (fig. 4, the insect natural size, 5 magnified). The eggs are oblong, of a yellowish-white, and shagreened.

H. vituli (the Calves' Louse) is a narrower species (fig. 6, the insect natural size, 7 magnified); of a chestnut colour, excepting the body, which is dirty-white, with two rows of oblong spots; the head is oval, but elongated.



Ox Louse, Swine Louse, and Calves' Louse: *Hæmatopinus eurysternus*, *H. urius*, and *H. vituli*

The pig louse is easy to treat on account of the comparative absence of hairs. The ox louse gives more trouble, especially as treatment is often necessary in the winter, when extensive washing is undesirable. Dilute carbolic acid, sublimate, kerosene emulsion, &c., are used for the purpose. In the United States a frequent practice is to wash the affected animals with a decoction of larkspur seed. [J. C.] [C. W.]

Hæmatopota pluvialis (the Cleg or Stout).—The female fly annoys horses, cattle, and even man by sucking their blood, which occasions great pain from the number of lancets that are forced into the wound. These flies make no noise, and alight so quietly that their presence is not suspected until the wound is inflicted. They are rather large grey flies, about ½ in. long, with dappled wings. They belong to the group of Breeze or Gad Flies (Tabanidæ). [J. C.] [C. W.]

Hæmoglobinuria. — This name is now accepted for an acute blood disease which seizes horses suddenly and without any previous symptoms of ill health. It was first called hysteria because the subjects happened to be mares, but subsequent observation proved that geldings and entires are not immune. The name of azoturia has been discarded, for reasons which will be made clearer by reference to the article on urine and its composition. A somewhat similar blood dyscrasia in cattle, and quite generally known as red water or black water, will be found under the heading RED WATER. Hæmoglobinuria in the horse follows upon a period of rest in the highly fed, when again put to work. The animal comes out of the stable 'fresh', and suddenly falls lame behind—so lame, indeed, as to suggest a broken bone or loin sprain; the muscles of the quarter are hard and spasmodically contracted; the animal breaks out in a sweat, and blows with pain and fear. If able to pass water without the use of the catheter it will be observed to be dark-red or purplish in colour. In bad cases the patient falls to the ground and struggles with the fore limbs, turning his head to the side, after the manner of a griped horse (see COLIC). The urine is found to contain an excessive amount of albumen. In the red water of cattle, the red blood corpuscles are broken up by the influence of bacillus introduced by the bite of an infected tick. The composition of so-called red water has led to the use of the term 'hæmoglobinuria' as the most descriptive. *Treatment* in the horse consists in removal to the nearest stable, a full dose of aloes, bleeding from the jugular vein, voluminous poultices to the loins, enemata of warm soapy water, and diuretics after the aloes have purged the patient. Spirit of nitrous ether is specially advised, as being both diuretic and stimulating to the prostrate animal. If convulsions continue, small and repeated doses of chloral are advised. Poultices may be succeeded by soap liniments, with massage over the loin region. A run at grass should be given the convalescent, but more or less paralysis too often remains. [H. L.]

Hæmorrhage. For causes and treatment of hæmorrhage, see art. BLEEDING.

Hail—Damage to Crops. — Although many years may elapse before a destructive hailstorm visits a locality, there are few who do not retain a remembrance of such a calamity. The subject is kept in mind every season by reports of such devastations, and insurance offices provide for the casualty at a low premium of approximately 1*s.* per acre. The first English society which instituted insurances against hail was the Royal Farmers' Fire, Life, and Hail Insurance Company in 1840, and since then most insurance societies provide against the contingency. Various methods have been in use for assessing the damages from hail, especially in Germany and France, but the matter being of a complicated character belongs to the general subject of insurance. In some cases the insurance is of a mutual nature, the precise amount of the premium being fixed at the end of each season, and made dependent upon the extent of the damage incurred over the whole area. A fixed and moderate premium is, however, to be preferred. [J. WR.]

Hail—Damage to Woodlands.—Hail, formed by sudden depressions in atmospheric temperature combined with electrical disturbances, causes damage by beating down, injuring, and often killing outright the young and

tender plants in nurseries and new plantations. *Throughout Continental Europe serious damage* is occasionally done even to older timber crops, through the often very large hailstones tearing off foliage and twigs and pieces of bark; but in Britain the chief damage to wood-crops is that *occurring from time to time among the osier holts in the fen* districts of eastern England, for *hail-smitten rods will not peel freely, and are* apt to break off at the injured parts when being used in basketmaking, &c. The thicker the foliage and the closer the branches, the less is any tree likely to be damaged; thus trees like Silver Fir and Spruce suffer less injury than Larch and Scots Pine. As large masses of woodlands tend to modify extremes of temperature, and to equalize the distribution of atmospheric electricity during storms, consequently extensive woodlands tend to prevent the formation of hail. Where damage is caused by hail, the only remedy is to cut back broad-leaved poles or saplings flush with the ground, and to replant blanks made in conifer plantations. Experience in Switzerland shows that belts of woodland along hillsides tend to prevent hailstorms passing over the crests of the hills. [J. N.]

Halms. See Hames.

Haining of Grass.—In Scotland it is, by the custom of the country, the practice in many districts that the outgoing tenant of a farm in which there is to be a hay crop is not entitled to pasture young sown grass, but is under obligation to *hain* or protect same for the benefit of the landlord or the incoming tenant. The period from which the grass must be hained varies, but is usually not earlier than 1st March or later than 1st April. This obligation extends to the whole of the ground which in ordinary rotation would produce a hay crop in the last year of the tenancy, and any breach in this duty will involve the outgoing tenant in damages. While this is the ordinary common law, the matter is usually made the subject of express stipulation in the lease. In such a case it may be provided that if the tenant should not continue occupancy under a new lease, the proprietor or incoming tenant shall be at liberty to provide the seeds for the ground to be laid down during the last year for hay, the tenant sowing, harrowing, and rolling them in without charge, and being under obligation not to allow any beasts whatever to pasture on the ground so sown down. If the outgoing tenant provides the seeds he has a claim for the cost thereof against the incoming tenant. [D. B.]

Hair.—In mammals there are always hairs on the skin, though they may be reduced to a very small number, as in whales and hippopotamus, and there are never hairs in other animals. The hairlike feathers seen on some birds, *e.g.* near the mouth, are peculiar barbless feathers, and the setæ of worms, caterpillars, spiders, and the like are not cellular structures, and not at all hairlike in structure.

A hair is a horny modification of epidermic cells; its base is sunk in an epidermic pit or hair-follicle into which two sebaceous glands open; it is fed at its root by a vascular papilla of the under skin or dermis. The core of the hair, often called the pith, contains air; the outer hor[n] part is much firmer, and without air. T[he] surface may be ridged or roughened in vario[us] ways (longitudinally fluted in sloths). T[he] roughened surfaces enable the hairs to interlo[ck] or become felted—a feature of great practi[cal] importance. In cross section a hair is usual[ly] cylindrical, but oval and flattened shapes are n[ot] uncommon. Ordinary fur shows strong contou[r] hairs, and, surrounding the base of these, numerous delicate curled woolly hairs. Different arrangements occur in different mammals; thus the jerboa's hairs form groups of about a dozen, the paca's form groups of three, and so on, but allied forms have often quite different arrangements.

The different kinds of hair may be arranged in a long series, beginning with short, delicate woolly hair, and ending with the spines of hedgehog and porcupine. We may mention (*a*) the 'under-fur' in some mammals (well seen in 'sealskin'), as distinguished from the longer coarser hairs; (*b*) the long curled hair of the sheep's

Hair, Hair Follicles, and Glands. *a*, Epidermis; *b*, True skin; *c*, Hair bulb; *d*, Sebaceous Glands; *e*, Muscle attached to hair sac.

fleece; (*c*) the long coarse hairs of manes and tails; (*d*) the bristles of pigs; and (*e*) the well innervated sensitive hairs (or vibrissæ) so well seen on the cat's head—about the snout, above the eyes, near the ears—and in some cases found near the wrist (as Beddard has shown in cats lemurs, various rodents, and marsupials). The scales of the pangolin (Manis) and the horns of the rhinoceros are believed to be due to the coalescence of a large number of hair rudiments.

The colour of the hair is due to brown pigments called melanin, which may be distributed in the hair in diverse ways and unequal quantities. Whiteness is due to the absence of pigment and the presence of gas-bubbles. When a hair turns grey, the pigment disappears from the cells of the hair and gas-bubbles take its place. According to Metschnikoff, wandering amœboid cells or phagocytes play an active part in removing pigment from the hair. A blanched hair cannot be repigmented, but it may fall out and its place may be taken by a new hair. In the ermine, according to Schwalbe, the white winter hairs are new growths which fall off in March and are replaced by the brown summer hairs of the stoat, which are different in detailed structure. In the mountain hare, according t[o] Loewis, the winter blanching is due to a chang[e] in individual hairs, which fall off in spring.

The chief use of the hair—which is a ba[d] conductor—is to economize the animal heat, an[d]

where hair is practically absent, as in cetaceans, the blubber performs the same function. In the hippopotamus and the elephant the thickness of the skin serves the same purpose. As the hair is fed by the bloodvessels in the dermal papilla at its base, anything seriously wrong with the animal may show itself very quickly in the character of the coat. The importance of a good cutaneous circulation is obvious; cleanliness and exercise are two conditions of this. The same remark applies to the functioning of the sebaceous glands, the secretion of which keeps the fur sleek. [J. A. T.]

Hair Balls.—Calves and lambs are subject to the formation of hair balls in the stomach. For causes and treatment, see BALLS and CALCULI.

Hair Grass, the common designation of grasses belonging to the genus Aira. See AIRA.

Hair Manure. See NITROGENOUS ORGANIC MANURES.

Halesia, a small genus of ornamental deciduous trees and shrubs (nat. ord. Styraceæ), natives of China, Japan, and the United States. The attractive white flowers are for the most part borne in drooping corymbs, and appear in May and June. *H. corymbosa*, Japan; *H. diptera*, United States; and *H. hispida*, China and Japan, are all large shrubs; while *H. tetraptera*, United States, the Snowdrop or Silver Tree, attains to a height of 20 ft. in this country. A sheltered position is the best for these plants, and they are increased by layers or by root cuttings. [W. W.]

Half-bred Horses. — To persons unacquainted with horses the above term conveys but one meaning, the half-bred animal being the product of two horses of distinct breeds. That this is not generally meant by those who use the term will be understood when we refer to old racing cards, in which the letters 'H.B.' were placed against an animal without a clean pedigree on both sides. What is usually understood by half-bred is pure blood on one side. There are to be found horses bred by a thoroughbred and a cart horse, and a sorry sort they are, as the blood does not mix satisfactorily, the produce too often being a blood horse at one end and a cart horse at the other. All the light horses in this country have a large infusion of 'blood', there being no special breed that has not at some time or other been improved by such crossing. The Cleveland Bay, the Yorkshire Coach-horse (a probable offshoot), the Hackney, and all the special breeds with now long-established pedigrees, were in the first instance the result of the crosses which produced the English thoroughbred, one of whose ancestors was purchased out of a water-cart in Paris, the Arab, the Barb, and others originally contributing to this world-famous breed (see the art. THOROUGHBRED). This being so, it follows that the progeny of any pure-bred horse from a mare of any other light breed in this country is much more than half-bred; but pure-bred on one side is what is generally meant. See also CROSS BREEDS. [H. L.]

Half-bred Sheep.—The term 'Half-Bred', though possibly a somewhat ambiguous one, designates the sheep produced by mating a Border Leicester ram with a Cheviot ewe, and is in contradistinction to 'cross-bred', the name which has been given for a considerable number of years to that class of sheep originated by mating a Border Leicester ram with a Blackface ewe. The Half-Bred is now extensively bred in Scotland and the northern counties of England. Although the chief home of the Half-Bred is in the border counties of Scotland and England, yet there are numerous flocks in Caithness-shire and Sutherlandshire, and these north-country sheep are sent down in considerable numbers to the Edinburgh and St. Boswell's markets in the autumn, where they command a ready sale owing to their size and hardiness.

The early history of the origin of the Half-Bred breed is somewhat obscure, but authorities generally agree in giving the credit to Mr. John Borthwick, West Newton, Northumberland, and Mr. Elliot of Lamberton, Berwickshire, of having established this breed, which has been continually improved by careful selection until it has become the most valuable of all the breeds of sheep in the south of Scotland.

The Half-Bred sheep may be produced in two ways: either by crossing a Border Leicester ram with a Cheviot ewe—which was the original way —or by mating two Half-Breds together. The first method (Leicester and Cheviot) is the more satisfactory, as one gets a better type of sheep, which is hardier and matures more quickly. Yet by interbreeding Half-Breds it is possible to obtain a larger and longer-sided sheep; but if the latter method be continued for long, there is no doubt the sheep tend to become neither so hardy nor such good provers. As a rule they are poorer nurses, and are not so well clad with wool. Consequently, although possibly quite successful on the lower, more sheltered farms, they are not so well adapted for the more elevated districts. Both systems are, however, extensively practised, and some well-known breeders — Mr. Elliot of Newhall among them — advocate strongly mating Half-Bred with Half-Bred. Mr. Elliot says: 'Although it is usual to have the rams of the first cross, I am quite convinced that it is perfectly practicable to breed them pure half-bred, if done with the skill of a judge'. If the necessary skill were exercised, the Half-Bred would soon become an established, recognized pure breed; but the general practice of breeding them by means of Border-Leicester rams and Cheviot ewes prevents this recognition, and proves that in the opinion of many competent judges the continuous breeding of Half-Bred and Half-Bred in time deteriorates the sheep.

By the crossing of the Cheviot with the Border-Leicester, a most valuable animal has been obtained. In the border counties of England and Scotland there is a large extent of land which, owing to situation and climate, is not quite suitable for Border-Leicester flocks and is yet too good for Cheviots; and again, on some lands Border-Leicesters become far too fat. These are the situations where the Half-Breds come in to such advantage. Owing to the Cheviot strain in its blood it has a hardier constitution and is

a closer-woolled and better-clad sheep than the Border-Leicester, and therefore can stand adverse climatic conditions better. Not only this, but it is a distinctly valuable mutton-producing sheep, the Border-Leicester strain giving it size, and the Cheviot strain counteracting the tendency of the Leicester to put on too much tallow and fat. The fleece also, pertaining more to the Cheviot than to the Border-Leicester in closeness, covers the body well, is very fine in staple, clips to heavier weight than the Cheviot, and is of considerably more value than that of the Border-Leicester; and taking the extra weight into consideration, the fleece is even more valuable than that of the Cheviot. A further recommendation is that the Half-Bred ewe, while being nearly as prolific as the Border-Leicester, is distinctly a better nurse, and always milks well.

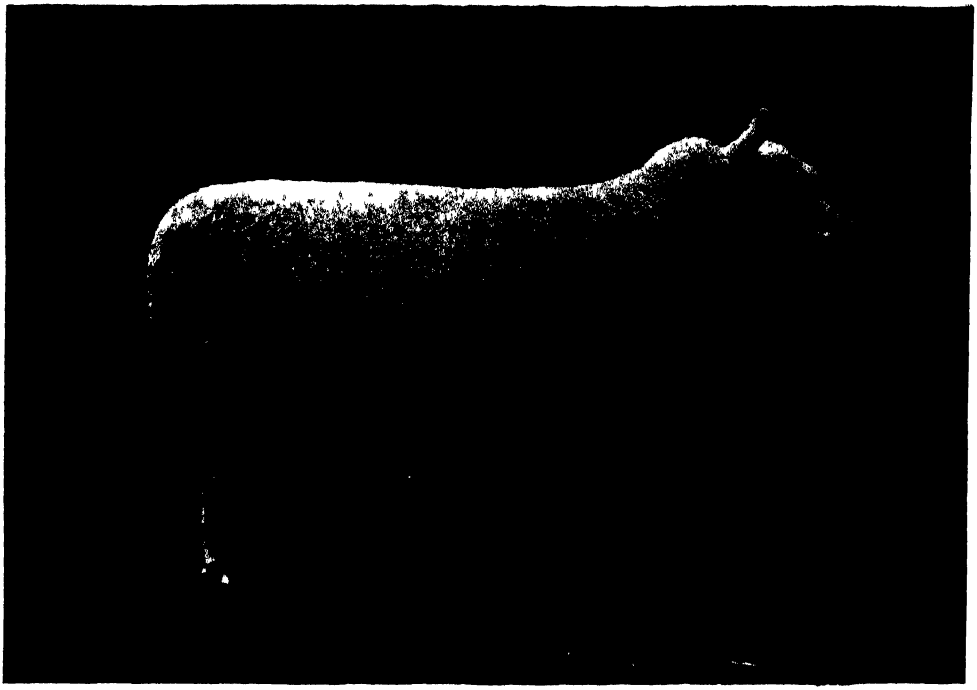
The typical Half-Bred sheep should have a large handsome head, well covered with fine white hairs (blueness and mottle are not to be desired); muzzle black and wide; eye bright; ears well set on and carried well, also well covered with white hair, and neither too long nor too short—an important point in making or marring the sheep's appearance; neck should be strong; good chest; body should be long and well ribbed, level along the back, and broad and square across the quarters; bones of legs large and flat, and legs should be straight, set well apart, and covered with white hair; the wool should be a close, thick fleece of very fine staple and should cover the body well, coming well down to the legs, and breast and belly should both be well covered. The sheep should be bright and active, carry itself well, and be a good walker.

Of the usefulness of the Half-Bred sheep there can be no doubt. They are the mainstay of the arable and mixed farms of the south-eastern counties of Scotland. They combine in themselves the excellences of the Border-Leicester and the Cheviot, being of good size, hardy constitution, and producing good, well-mixed mutton and a heavy fleece. They are prolific—four ewes out of five producing twins; they are also exceptionally good nurses, and they possess a distinct monetary value.

Up to about the last ten years the general custom of farmers who kept a Half-Bred ewe flock was to cross the ewes with a Border Leicester ram, and the progeny — called three-quarter-breds or three parts bred—were either fattened during the ensuing winter at home, or were sold at the great lamb sales, where they were bought by farmers in all parts of England and Scotland for feeding purposes. These three-quarter-bred lambs are exceptionally quick feeders and grow to good weights. Ewe and wedder lambs were sold together, and, according to the price of mutton and wool, and the prospects of good turnip crop, varied in price from about 25*s.* to 36*s.* per head for the top draft. However, owing to the tendency of the three-quarter-bred lambs to put on too much fat, many breeders have during the last few years used, instead of a Border-Leicester ram, an Oxford or Suffolk ram. This gives us the cross Oxford or cross Suffolk lambs, which, though perhaps not quite such kindly feeders as the three-quarter-bred lambs are, grow to good size, and give a very good useful commercial carcass when killed. The Wensleydale ram and the Roscommon have also been used; the produce of the latter is a useful sheep of great size and bone, though perhaps a little coarse in appearance. A considerable number of large farmers still prefer to use the Border-Leicester ram, as they consider that the larger heads of the Oxford and Suffolk crosses make it much harder on the ewes at lambing time. As the three-parts-bred lamb is equally as well adapted for the fat-lamb trade as these other crosses, and as there are still many feeders who prefer the three-quarter-bred lamb for its early maturity and profitable return, the tendency has latterly shown itself in a stronger demand for three-quarter-bred. This seems to point to the fact that the merits of the cross Oxford and cross Suffolk have been rather overrated. Where this system of crossing the ewes and feeding or selling all the produce—ewe and wedder—was practised, the farmer, if he had not also a stock of Cheviot ewes from which to breed his Half-Bred ewes, was forced to have recourse either to putting a certain number of his Half-Bred ewes, principally gimmers, to a Half-Bred ram—which is practised by many—or to go to the markets and purchase Half-Bred ewe lambs or Half-Bred gimmers. The Half-Bred ewe lambs, generally out of Cheviot ewes from the higher-lying farms, owing to this demand, command high prices—up to 40*s.* being paid for good ones. The gimmers, too, if good, command from 42*s.* to 56*s.* per head, and a considerable number of these gimmers are sent south from Caithness-shire and Sutherlandshire to the autumn sales. Some farmers prefer to buy these north-country sheep, as they consider they grow better, are hardier, and thrive better than the local-bred ones, owing no doubt to the change of climate, and to their coming from a poorer to a better soil.

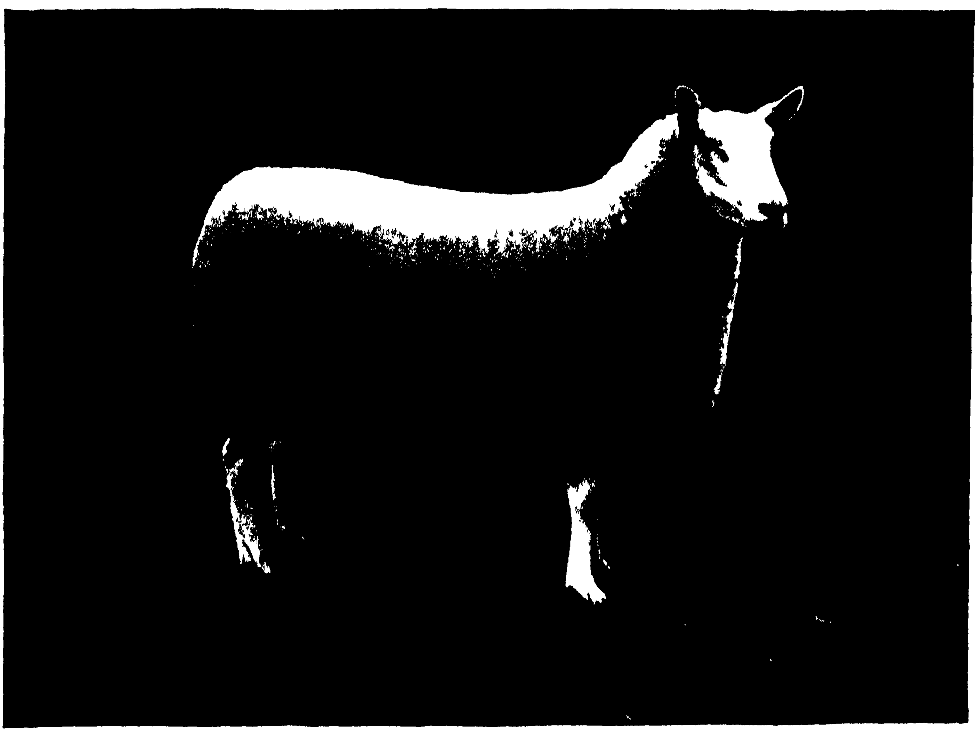
After three crops of lambs have been taken, the ewes are drafted away at the annual draft ewe sales. The ewes, when guaranteed correct in udder and teeth, bring from 42*s.* to 56*s.*, according to the state of the market and the flocks from which they are drafted. These ewes are bought by farmers on the lower arable farms, who put generally an Oxford or sometimes a Leicester ram among them as early as possible to get them to lamb early for the fat-lamb trade, in which case both ewe and lamb are fed and sold during the months from February to May. In recent years this trade has increased enormously, and the Half-Bred ewe is the very best mother for this purpose. The unguaranteed ewes are sold as such at the same time as the guaranteed ones, or are fed at home.

The reason mentioned above, of farmers being compelled to interbreed Half-Breds, causes a considerable trade in half-bred rams, and although these rams do not command very high prices, yet a good trade is done in them. Thirty-five pounds is the highest price yet paid, and the average in 1907 for 485 rams sold at Kelso Ram Sales was £7, 2*s.* The great popularity of this



HALF-BRED GIMMER

1ST AT THE H. & A. S. SHOW, 1907



HALF-BRED EWE

WINNER OF FIRST PRIZE AND PRESIDENT'S MEDAL, H. & A. S. SHOW, 1907

breed of sheep is amply borne out by the size of the lamb, ewe, and gimmer sales held in July, August, and September at St. Boswell's, Haddington, Duns, Reston, Peebles, and elsewhere. At the Lammas sale at St. Boswell's, 25,000 to 30,000 three-quarter-bred cross Oxford and Half-Bred lambs will be sold in a single day.

A perusal of the above sketch of the Half-Bred breed of sheep will bring before anyone the characteristics and many uses of this breed; and if these uses are taken full advantage of, and combined with good management of the flock, this class of sheep will prove to be the most valuable breed in Scotland from a commercial point of view. The general management of the flock is similar to that of other breeds of sheep; but it must be borne in mind that the Half-Breds, owing to their greater size, heavy fleece, and greater reproductive powers, require a better class of treatment than Cheviots. The following is an outline of the system of management pursued on a well-known farm in the Border country, where the Half-Breds are bred from the farmer's own stock of Cheviot ewes. Taking September as the beginning of the year, the ewes are brought in from the hill, where they have been since weaning time, to better and clean grazing, with a run on the oat stubbles; and a fortnight before the rams are put among them, which is generally about October 22nd, they are given some extra feeding to flush them. The best ewes are tupped on the seeds, if these can be spared, and this generally results in a heavy crop of lambs. The rams used are Border-Leicester, and fifty to sixty ewes are allocated to each ram; the ewes generally having been more or less roughly classed, so that those which are defective in any point are put with a ram strong in that point. The gimmers are mated with smaller, more compact rams, so that their produce may be more easily carried and nursed. After tupping is over, the ewes are allowed to run in the grass fields; but if grass is bare, a few turnips are fed to them, until the middle of November or beginning of December, when they are folded on to the turnips from four to six hours in the forenoon, and run off to a grass field in the afternoon. About the middle of January they are run on to a bare break and are given cut hay or cut tare hay until lambing time, which generally falls about March 18. In the lambing field they have turnips laid down to them, and in addition a mixture of bran, lentils, and oats is given in the morning. The ewes with twins are given the young grass and best of the second year's grass, from one-and-a-half to two sheep per acre being allowed, according to the quality of the pasture. All box feeding is stopped at the end of May. Singles are put on rest of second year's grass, as lambs do not thrive so well on old grass. The ewes are weaned in July, after which they are run on the hill until milk is off them. They are then brought in, and the ewes from which three crops of lambs have been taken are drafted. Mouths and udders are examined, and all the 'correct' ewes are run on to better pasture to freshen up for the draft ewe sales, where they are sold. No extra feeding is given. The whole stock of ewes is examined for defective mouths and udders, and any so found are drafted out, as well as any soft-constitutioned sheep or any that have not come out well. Their places are filled with the best of the Half-Bred gimmers out of the Cheviot ewes. The first draft of three-quarter-bred lambs is sold in the middle or end of July. A Half-Bred ewe is a heavy eater, but careful and generous treatment will amply repay the farmer, and lead to the Half-Bred stock becoming a valuable investment. [A. G. S.]

Half-hardy.—This term is used for plants, other than perennials, that require protection during a portion of the year. Examples: Ageratum, China Aster, Balsam, Petunia, Tobacco, and Celery. [W. W.]

Half-inch Bones, a coarsely-ground form of raw bones in which the pieces reached the half-inch size. Half-inch bones used to be a very popular bone manure, but on account of their slow action they have largely fallen into disuse. See BONE MANURES.

Halflinger Pony.—This is a very hardy pony breed found in the Tyrol districts of the Alps, and which, on account of its surefootedness and strength of limb, is admirably adapted for draught and riding purposes in these mountainous districts. The Halflinger pony stands about 13 hands high, has a well-made, compact body, and good feet and pasterns. It is slow but safe. Unfortunately the breed is gradually becoming extinct through indiscriminate crossing.

Halter. — Halters or headstalls are practically bridles without a bit, and are used for tying up animals in the stable or other places when they are not at work. In some districts leather halters are mainly used, and in others hemp halters are in common use. The best are of leather, with two cheekpieces, a nosepiece, and poll band with a throat latch for securing to the head. A chain or piece of rope is attached for leading or tying. [W. J. M.]

Halticidæ (Flea-beetles), a family of small beetles characterized by the great development of the femora or thighs of their hind legs, which enable them to jump like fleas.

Haltica oleracea is the Cabbage Flea-beetle. It abounds in May and June on seedling cabbages, and is peculiar in attacking the *upper* epidermis of the leaves. There are about five broods in the year, and the beetles hibernate. They may be caught on tarred cloths stretched on frames and drawn across the plants, or the plants may be sprayed with arsenate of lead, by which the beetles feeding on them are poisoned.

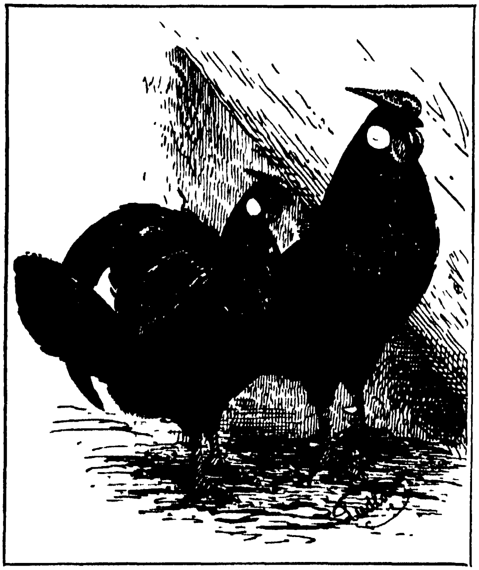
For the Hop Flea-beetle see PLECTROSCELIS CONCINNA, and for the Turnip Flea-beetle or Turnip-fly see PHYLLOTRETA NEMORUM. [C. W.]

Hamamelis (Witch Hazels), a genus of Hamamelidaceæ, comprising a few species of deciduous winter-flowering shrubs or small trees which are, with one exception, natives of Japan. The flowers are small but attractive, and as they are borne in midwinter and remain open for a considerable time, the best kinds are admirable subjects for planting. These are *H. arborea*; *H. japonica* and its variety *Zuccariniana*; and

H. mollis, the best of all, having the finest flowers, and large handsome hairy leaves. *H. virginica*, United States, the earliest to flower, is not so good for garden decoration, but a specific for bruises, insect bites, &c., is prepared from this plant. A light loam or peaty soil is the most suitable. Propagation by layering or by grafting. [W. W.]

Ham and Ham Curing. See BACON-CURING.

Hamburgh Fowl.—Although the Hamburgh is one of our most prolific layers, yet from the fact that the eggs are small it has never become very popular as a utility bird, being chiefly kept for exhibition or for the supply of eggs for household purposes, and not



Black Hamburgh Fowl

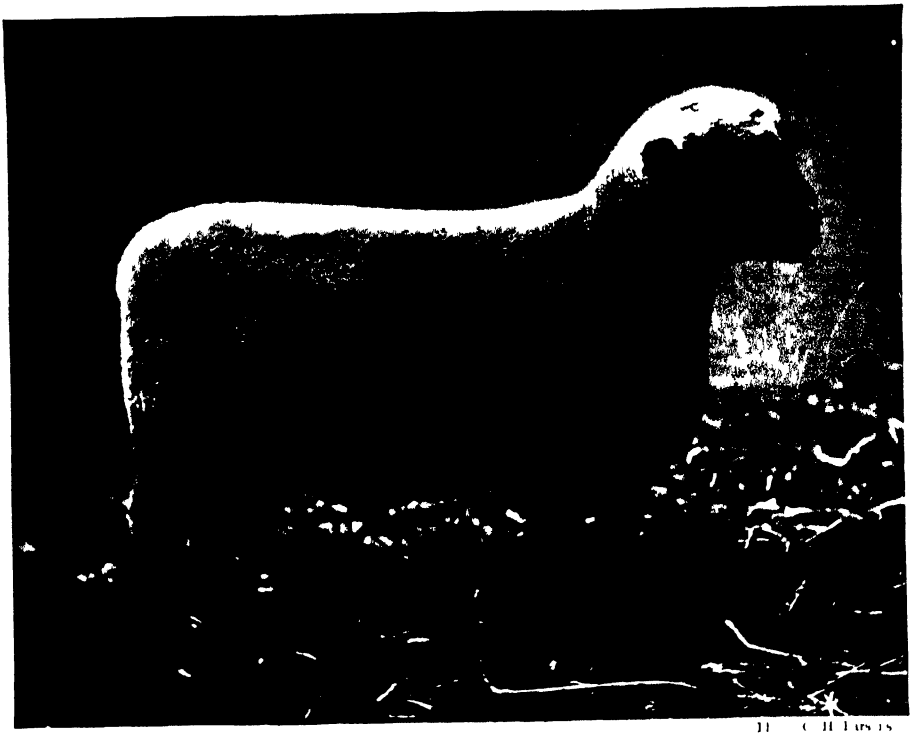
for sale. It is one of the most beautiful of our races of poultry, combining brilliancy of plumage with graceful carriage and a well-balanced body. The head is decorated with a neat rose comb, entirely conforming to the body, and the male birds have full flowing sickles in the tails. They are very active, and as they fly more than is generally the case with domestic poultry, they are not suitable for keeping in confinement.

It would appear that this breed originated in Holland, and is probably descended from what is known as the Friesland fowl, met with in the northern part of that country. The name probably originated from the fact that birds originally were brought from the port of Hamburgh, but some of the varieties of this breed have been known in England for a very long period of time, certainly more than a hundred years. There are five colours in all—the gold-spangled, silver-spangled, black (which three are oldest so far as Britain is concerned), and the gold-pencilled and silver-pencilled. The meaning of these terms is that in the spangled each feather is fringed with a round black moon or spangle, and in the pencilled the feathers are marked across with pencilled bars of black, the ground colour in the golds being golden-bay, and in the silvers a steel-grey. Of these, the Blacks and Silver-spangled are the best for practical purposes, as the eggs are largest in size, but even these do not meet market requirements. The hens are non-sitters, and, as already indicated, are very prolific layers, it being no uncommon thing for a single bird to produce 250 eggs in the course of twelve months, but these eggs do not scale much more than 1½ oz. each. In size the birds themselves are small, ranging from 3½ to 5½ lb., the Spangled and Blacks being the largest. The Hamburgh, being so small, is not bred for table purposes, but the flesh is of good quality. [E. B.]

Hames.—Hames are attachments to the horse collar to connect the horse with the traces or draught chain, and are made of wood with metal hooks, or with metal throughout; for carriage work they are encased in leather. The 'sit' of the collar is largely dependent upon the position of the draught hooks. Many horses suffer by the collar being drawn on to the windpipe, while others get their withers wrung by careless adjustment. As a rule, the draught hooks should be placed so that the collar lies well-fitting to the shoulder when the horse is pulling. When too high, especially in shaft work, the horse frequently has to lift the shafts with its neck; when too low, the shoulder action is impeded. Want of care in fitting hames is one of the chief causes of distress in horses. [W. J. M.]

Hammer.—Hammers of various kinds are required on the farm. The cowman and the shepherd each should always be provided with a small outfit of carpentering tools to mend hurdles, fences, feeding troughs, mangers, and other things under their charge. Nothing is so important as a hammer, as by early attention much subsequent injury may be saved. Each should have a good stout claw-hammer with deep socket or side stays, as well as another with a flat tack end. An 8-lb. sledge-hammer is also handy for many purposes; and to save waste, a pick-end coal-hammer is necessary. [W. J. M.]

Hampshire Down Sheep.—If not a perfect sheep, the Hampshire is one of the finest in the world in size, form, colour, and early-maturing properties. The writer has had experience with the variety, both as breeder and feeder, and can testify to its value as a source of profit to the farmer. The Hampshire has a golden hoof on soil adapted to its growth, the lambs realizing remunerative prices in the early markets. It is the custom to feed them on roots, vetches, clover, trifolium, and other suitable crops right up to barley sowing. The lambs are allowed to run forward and to consume the most tender parts of the crops provided, troughs being placed outside the folds and supplied with cake, corn, and hay chaff mixed together. The facts which follow will afford practically every phase of information which may be desired: their points, their weights as ascertained at Smithfield, and the prices real-



H. C. H. Davis

HAMPSHIRE DOWN SHEARLING RAM

1ST PRIZE WINNER R.A.S.E. SHOW 1909

C 66

HAMPSHIRE DOWN EWE

ONE OF THE 1ST PRIZE PEN OF EWE LAMBS AT THE SALISBURY SHEEP FAIR 1908

ized for breeding stock. There is perhaps no finer sight to be seen than the huge flocks which are collected for sale at Wilton, Overton, Weyhill, and other fairs, where Hampshire Downs form the chief contribution. If the prices realized do not reach those obtained for Lincolns they are frequently very high, and where pains are taken to select the best in form and quality, and to secure a careful and well-skilled shepherd, we may rest assured that no live stock of the farm is more remunerative.

Points of the Breed.—The chief points of a true-bred Hampshire sheep are: a long, deep, and symmetrical carcass, with the ribs well sprung, broad straight back, flat loins, full dock, wide rump; deep and heavily developed legs of mutton and breast; head and neck well placed on gradually sloping and closely fitting shoulders, the neck being particularly of a strong muscular growth and not too long; the ears nicely set on, of fair length and whole-coloured, prominent intelligent eye; the body, as above described, standing on strongly jointed and powerful legs, with good feet, presenting a smart and attractive appearance.

In the Flock Book of the Hampshire Downs, the first volume of which was published in 1890, a few leading and important facts were referred to by two of the best judges in the county of Hants, Mr. Elias P. Squarey and Mr. J. E. Rawlence, both high authorities; Mr. Rawlence in particular having sold at the chief fairs in the Hants district perhaps more Hampshire Downs than any man in England. These gentlemen believe that 'the Hampshire Down sheep undoubtedly dates its origin from the crossing of the old Wiltshire Horned sheep and the old Berkshire Knot with the South Downs, which were introduced into Wilts and Hants early in the 19th century.

'For a long time the high quality and charming character of the South Downs, with their fine form, satisfied the most advanced of the Wilts, Hants, and Dorset farmers, and it was not until they realized how much they had lost in the size, early maturity, and hardihood of constitution, which existed in the old Wiltshire type, that they bethought them of recurring to those animals to give additional substance and development to the South Downs. These crosses were made with varying success, and the result depended simply upon the instinctive capacity of the farmer to properly select the animals for this purpose. Whilst one aimed at the production of a large-framed, long-wool-producing hardy animal, another devoted his attention to the maintenance of the high quality and beauty of the South Down with earlier maturity and greater size; and, as a consequence, there existed various types of sheep, which still required to be reduced into a distinct and uniform breed.

'From about 1815 to 1835 the Hampshire Downs of the north of Hants and the south of Wilts were totally dissimilar in character, and it was evident that the leading ram breeders of each district had aimed at and had secured a different type. The north and east Hampshire sheep were large, muscular, early-matured animals, growing a fair quantity of wool of moderate fineness; the head large and well set on, of dark-brown colour, verging towards black, covered with coarse hair, with Roman nose, the neck with greatly developed muscles; the ears thick, of the same colour as the face, and there was an occasional tendency to recur to the original type, by producing "snig horns"; the legs with large bones, and in the most strongly marked types the wool growing below the hocks and knees. An occasional white spot was exhibited on the face, ears, or legs; but the efforts of ram breeders were uniformly directed to avoid this, and to procure perfect uniformity of colour. On the other hand, the Wiltshire breeders had adopted a more largely framed and probably less handsome animal than their Hampshire brethren. They were less careful as to the uniformity of colour, and ewes with speckled faces or ears were not dismissed from their flocks, provided they had size and other good qualities.'

The society now records the dispersals of flocks, and among those of the most recent past are the flocks of Mr. William Baring, the Earls of Carnarvon and Darnley. There is also a shepherds' prize competition, in which four prizes are awarded in each of three classes for shepherds rearing the largest percentage of lambs. The classes are determined in accordance with the sizes of the flocks. The first prize in the class for ewes exceeding 600 was won by John Maynard, shepherd to Mr. F. Mills, with 118½ per cent lambs, the ewes numbering 648; but this percentage was much exceeded in the second class, between 400 and 600 ewes, by Walter Cooper, shepherd to Mr. Melsome, 135 per cent lambs, the ewes numbering 467; while in the next class the number of lambs reared was 132 per cent, the ewes numbering 353. Prizes are also offered to shepherds for rearing the largest percentage of tegs, while thirteen shepherds were awarded small prizes for having reared their flocks of tegs without loss, and in a similar class eighteen shepherds were similarly awarded prizes. The Hampshire people also provide three classes annually for flocks. The number entered in the last flock book, that for 1908, covers 235 pages of the volume, there being practically an average of two flocks to the page.

The Hampshire Down Society is governed by a council of the leading breeders in the country, the treasurer and secretary being Mr. James Edward Rawlence, of Salisbury, himself a leading breeder, and a member of the old firm of land agents of Rawlence & Squarey.

Mr. Cary Coles, president of the Hampshire society, a highly skilled flockmaster, regards the Hampshires as a cosmopolitan breed which adapt themselves to almost any locality—particularly light arable land. There are flocks scattered throughout England, with a few in Ireland, and many sheep are annually sent to Wales and Scotland for breeding purposes. In the south-west of England they are the principal breed, particularly in Wilts, Hants, and Berks, and part of Dorset.

There are 456 registered flocks entered in vol. xix (the latest issue) of the Hampshire

Down Flock Book. About half this number are in Wilts, one-fourth in Hants, the remainder in sixteen English counties, with two flocks in Ireland. The registered flocks include between three and four hundred thousand sheep, and probably unregistered Hampshire Downs are in much greater numbers in England than those entered in the flock book. Hampshire Downs are exported in large numbers to North and South America, Germany, and Russia. A few sheep are also exported to Australia and South Africa. This breed is particularly noted for its early maturity, combined with the production of prime-quality meat. Lambs at twenty weeks old often weigh 150 to 160 lb. alive, or 75 to 80 lb. carcass weight. At Salisbury Fair (July 15th) and Overton Fair (July 18th), wether lambs in lots of one hundred may be seen which would average from 76 to 80 lb. of prime mutton, and, at current prices, realize from 50*s.* to 55*s.* each from the butcher. These lambs were probably dropped in the January and February preceding, their average age being about twenty-five weeks old. When it is remembered that these are sheep kept solely for commercial purposes, the claim of Hampshire Down breeders 'that their sheep, for early maturity combined with high-quality mutton, are the premier breed', is amply justified. Hampshire Downs for mutton are generally sold at carcass weight of from 72 to 90 lb. each, these being the favourite weights with butchers; but these weights are easily exceeded—wether lambs at Smithfield Christmas Fat-stock Show, at ten months two weeks old, averaging 214 lb. live weight, with a probable carcass weight of 140 lb.; older show sheep, ewes, wethers, and rams sometimes reaching a live weight of from 300 to nearly 400 lb., with a carcass weight of from 200 to 260 lb.

Hampshire Down ewes, shorn in the grease, clip, in the experience of Mr. Coles, from 6 to 12 lb., rams from 10 to 18 lb. Hampshire Down grease wool now sells at from 7*d.* to 8*d.* per lb., which is the highest current price for English wool, excepting, perhaps, South Downs. Grease wools are estimated to lose one-third weight in washing, and the prices for average washed Down wools are from 10*d.* to 11½*d.*, which agrees with the calculated shrinkage by washing. Hampshire Downs are offered for sale in large numbers at the sheep fairs in Wilts and Hants, amongst them Salisbury, Britford, and Wilton in Wilts, and Overton and Weyhill in Hants. At some of these fairs fifty thousand sheep are sometimes penned, nearly all being Hampshire Downs. Through the early maturity of Hampshire Downs it is customary to use ram lambs more than older rams as sires; and, through the deserved reputation of this breed for prime mutton, very many Hampshire Down ram lambs are used with ewes of other breeds for producing better butcher's sheep and a higher price for the breeder. In the cross-bred sheep classes in fat-stock shows it will generally be found that the Hampshire Down cross exceeds any other, both in number and prize awards. In consequence of the demand for ram lambs for crossing, probably double as many as are required for service with Hampshire Down ewes are kept as rams. There is a great difference in value between ram lambs suitable as sires in the leading registered flocks, and those sold for crossing other breeds of sheep. Lambs for crossing make from £5 to £6 each, whereas at the best flock auction sales ram lambs often fetch from 10 to 100 gs., occasionally up to 200 gs., and in 1905 and 1906 a ram lamb let for two months' service at 205 gs., and in 1906, of a twin of ram lambs, one let for 205 gs., the other lamb for 120 gs., so that the produce of one ewe for two months' hire realized £341, 5*s.* At their first draft auction sales leading breeders have averaged over £21 each for from 80 to 100 ram lambs. Shearling ewes in hundreds from good flocks sell at from 50*s.* to 60*s.* per head, older ewes from 45*s.* to 55*s.* At dispersal sales, of leading registered flocks, picked pens of five ewes sometimes sell at nearly £20 per sheep, a whole flock of several hundred ewes in mixed ages averaging about £5 each.

Referring to the pecuniary value of the Hampshires, Sir George Judd says: 'This favourite breed of sheep may be described as the rent payers, and therefore as the backbone of agriculture on the high and dry uplands of Hampshire, Wiltshire, and adjoining counties. The Hampshire Down of to-day is a very different type of animal to the Hampshire Down of fifty years ago; instead of the leggy, narrow, weak-shouldered sheep of that period, we have a breed combining great size with superb quality both as regards flesh and wool. At three months old they easily make 40*s.* each if well fed; at five and six months old they make up to 50*s.* or 55*s.* per head for mutton. With the single exception of the South Down, they are not surpassed for quality of mutton. They will come to great size and heavy weights if required, but the demand for heavy sheep is very small, and as a rule it pays best to sell when they turn the scale at 10 st. or 80 lb.

'Hampshires do best where some turnips or rape and tares are grown, though they will do well on grass when the weather is not too wet.

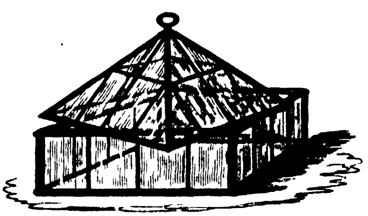
'The late Mr. James Rawlence', says Sir George Judd, 'was a foremost breeder at the time I first engaged in agriculture, and of other successful breeders who did much to improve the breed I may mention the late W. Parsons of West Stretton, Hants; Mr. James Flower; the Coles family, including Mr. Cary Coles of Wiltshire; these latter gentlemen are still doing good work as breeders, also Mr. H. C. Stephens, who had a successful career in the show yards during the season 1908. In counties farther removed, we have Mr. Lambert, of Cambridgeshire, and Mr. Buxton in Hertfordshire, and Lord Rothschild. The fine flocks of Hampshires greatly diminished after the disastrous year 1899; still, there are many large flockmasters in Hants and Wilts, besides ram breeders who devote much time and attention to keeping their flocks up-to-date.'

Some idea may be formed of the value of ram lambs from the following example: 'The annual letting and sale of ram lambs at Winterbourne Stoke has long since become one of the chief events in the Hampshire Down world. Business

commenced with the letting of eight ram lambs, and of these Nos. 1 and 2, the twin produce of a favourite ewe in the flock, realized no less than 325 gs., Mr. J. Flower securing No. 1 at 205 gs., and Mr. A. F. T. Drake No. 2 at 120 gs. Mr. Dibben hired No. 3 at 24 gs.; Mr. Lambert No. 4 at 45 gs.; Lord Rothschild No. 5 at 96 gs.; the Marquis of Winchester No. 6 at 52 gs.; Mr. Holman No. 7 at 54 gs., and Sir G. Judd No. 8 at 30 gs.; the average being £82. Of the eighty-two selling lambs, Mr. C. Bugg secured No. 15 at 60 gs.; Captain Morrison's agent buying at 40 gs. and 30 gs.; Mr. Holman at 24 gs.; Mr. B. Hanbury at 28 gs. and 20 gs.; Mr. Hurford at 34 gs.; Mr. J. Brown at 28 gs. and 22 gs.; Mr. T. N. Coles at 18 gs.; Mr. Chalker at 10 gs.; Mr. A. Edwards at 16 gs.; Captain Lano at 21 gs., 13 gs., 12 gs., and 10 gs.; Messrs. Inkpen at 13 gs. (twice); the Hon. Louis Greville at 15 gs.; Mr. Molyneux (for Mr. W. H. Myers) at 40 gs. and 30 gs.; Mr. Kerr (for Mr. H. C. Stephens) at 36 gs.; Mr. Ovey at 30 gs.; Mr. Harding (for Sir W. G. Pearce) at 42 gs. and 40 gs.; Mr. Priddy at 11 gs.; the Marquis of Winchester at 24 gs., and Lord Wolverton at 24 gs.' [J. Lo.]

Hand, a measure of 4 in. The height of a horse is usually stated as so many hands, the measurement being taken from the point of the withers.

Hand-glass, a miniature greenhouse with square sides and a movable top, used for placing



Hand-glass

over plants that require protection; also for the propagation of cuttings. The frame is usually constructed of zinc or iron, but now that glass is so cheap, wood might be used, and each side consist of a single pane of glass. French gardeners prefer a large bell-glass (*cloche*), as it is cheaper, more portable, and serves the purpose equally well. [W. W.]

Hand Labour. See Labour.

Hand-picking.—Although machinery has taken the place of manual labour in many operations of the farm and garden, there are some which can only be satisfactorily performed by hand. The gathering of fruits, for example, although more costly when done by hand as compared with the destructive method of beating or shaking them off the trees, is the more economical in the end, because so few of the fruits are bruised when they are hand-picked with ordinary care. It should be borne in mind that fruits require to be handled with as much care as if they were eggs. To use sufficient labour and appliances, when harvesting apples, pears, cherries, and plums, so as to permit of each fruit being picked from the trees by hand and placed at once into the baskets for market or into trays for storing, is only to prevent serious injury and subsequent loss. Labour is cheap enough and sufficiently deft to justify hand-picking. In Germany, manual labour is largely used in harvesting seeds and fruits from the farms, school children being employed for the purpose. [W. W.]

Hand Weeding. See Weeding.

Hanoverian Horse.—This world-known variety, undoubtedly a descendant of the old Danish horse, has for so long been associated with the royal house of Hanover that its practical extinction will be regretted by many persons who do not interest themselves in equine matters. Until the time, however, of the German occupation of Hanover, these horses were treasured immensely; and even since the event referred to, the stud was kept up at the stables of Herrenhausen, but recently it has been disbanded. There were two breeds of these horses in the Herrenhausen stud, one of which was pure-white, whilst the other was cream-coloured. The former, it may be mentioned, were only used on state or semi-state occasions for drawing the coach of the King of Hanover, whilst the creams or Isabels, by which name they were known, were similarly devoted to the service of the Queen. This fact probably influenced the gift many years ago of a team of cream colours to Queen Victoria on the part of her uncle the late King of Hanover, and from these the horses used in His Majesty King Edward's state coach and the members of the stud at Bushey Park are descended. A peculiarity of the breed to which the white horses of Hanover belong, is that all the foals come into the world pure-white in colour, and not of the dark shade of coat which is invariably associated with greys of any other breed; hence the local name of white-boned horses which is applied to them. For the most part the two studs at Herrenhausen were composed of very tall horses, as none of them was less than 16 hands 1 in.; still, they were not conspicuous for the quality they possessed, being for the most part plain about the neck, whilst the quarters, though long, were extremely narrow for the size of the horses. Their middle pieces were good, though some of them might have been better let down behind the forearms, which gave them a leggy appearance, and in several cases the feet were thin and badly shaped. It must, however, be mentioned, in justice to the horses, that the majority of them were very old when the writer enjoyed the privilege of going over the Herrenhausen establishment, which was the only one in the world, with the exception of that at Bushey Park where the royal creams are bred. For the most part, the Hanoverian horses were famous for their excellent tempers, but, on the other hand, the exceptions to the rule were, usually, extremely savage. The breeds were notable for their longevity as well as for the peculiarity of their colours, and it is greatly to be regretted that the famous White Horse of Hanover should have been allowed to die out, and that the English stud is the only one containing Isabels or creams. [V. S.]

Hard Cheese.—The fundamental difference between hard and soft cheese is broadly that of pressure instead of gravity in the process of making hard cheese of any kind. But there is one famous exception that may be cited, viz. Stilton cheese, which is a hard cheese not subjected to external pressure; but it must be borne in mind that Stilton is pretty near to the line which divides hard cheese from soft cheese, but lies much nearer even to Cheshire, for instance, than to Camembert. The pressing of hard cheese, done to consolidate it into a compact form and to make it hard, expels the rest of the whey quickly, and in so doing reduces lactic fermentation and admits of slow ripening, as well as of deferred decay.

But the pressure to which hard cheese, other than Stilton and Gorgonzola, is subjected does not wholly stop fermentation. The action of lactic acid in the cheese is continued, though slowly, during the ripening process, and performs a service that is not dispensable from a perfect ripening of cheese. Trained cheesemakers of to-day regulate and control the action of lactic acid, before as well as after coagulation, because a good servant may readily develop into a bad master, and a hard cheese may become a dry cheese too, that will not ever ripen as cheese ought to do. If a hard cheese—a Cheshire, a Cheddar, a Derby, or a Leicester, or any other English cheese of the class—half ripened or less, shall emit a faint acid odour in a trying-iron when bored, we may calculate that the lactic ferment is slowly doing its work and that the cheese will ripen well.

One of the predominant merits of scientifically made hard cheese, in which the lactic ferment has been judiciously employed, is its immunity from early decay. Soft cheese does not enjoy this immunity. And it follows that an owner of a first-class dairy of hard cheese, be he farmer or dealer, is master of the situation, for he can hold keeping cheese until a favourable opportunity occurs to sell it. And a perfectly made cheese of this description is a better and a nicer, and altogether a more excellent food at sixteen months old than at six, and even—in many cases where the experiment has been made—at two years old than at one. [J. P. S.]

Hardening Off, the process of inuring plants to a lower temperature than that in which they have been previously grown. The gardener is often compelled to employ excessive heat to induce seeds to germinate quickly, cuttings to strike root, or to force on plants for a special purpose. Their removal at once from a high temperature to one considerably lower would be harmful; he therefore places them for a few days in a temperature a few degrees lower, repeating this until the plants are hardened sufficiently to bear the position for which they are finally intended. [W. W.]

Hard Fescue Grass (*Festuca duriuscula*) is a perennial species like Meadow and Tall Fescues, but unlike these the leaves are bristle-like, and the spikelets of the ear have long beards or awns. The grass grows naturally on dry hill pastures, and in the Highlands ascends to a height of 2700 ft. Its whole habit, indeed, shows marks of adaptation for a life of the hardiest kind. The leafy shoots are packed close together into a tuft, so that each shoot protects the other. To withstand drought, the leaf-blade is extremely narrow and folded along the middle line; thus is produced the hairlike blade with the surface reduced to a minimum so as to also reduce the loss of moisture from transpiration. For reproductive purposes, numerous fine straws (culms) with panicle ears of awned spikelets are produced. The straw is usually about 1 ft. high. The ear is in flower about the end of June, and the seed is ripe by the end of July.

Hard Fescue is an important agricultural grass on exposed dry and unproductive sandy soils where better grasses do not readily grow. Its low habit of growth makes it suitable for pasture rather than for hay. Sheep are very fond of it, and on many hill pastures, along with Sheep's Fescue, it forms the bulk of the herbage, yielding early and late pasturage. By reason of its tufted mode of growth it should be sown along with plants of a creeping habit, such as white clover and Smooth-stalked Meadow Grass (*Poa pratensis*). To sow a whole acre with Hard Fescue, about 18 lb. of pure germinating seed is required. For mixtures on good land, 1 or 2 lb. may be used for forming bottom herbage. The yield is very low at first, and by the third year the grass is at its best. See FESCUE GRASSES.

[A. N. M'A.]

Hardhead, the popular synonym for Knapweed or *Centaurea nigra*, a common weed in pastures. See CENTAUREA.

Hardwoods are those kinds of timber trees whose wood offers a considerable degree of resistance to the penetration of another body (*e.g.* a nail) into its substance, in comparison with the decreased resistance offered by other kinds consequently known as softwoods. From a technical point of view, however, this definition is rather lax and indefinite, because any one kind of wood may exhibit a varying degree of hardness when operated upon by different kinds of instruments, such as a knife or a plane working parallel to the fibres, or an axe, saw, turning-lathe, or rasp working at right angles to them. Thus a nail driven in following the run of the fibres has nothing like the same resistance offered to it as when it is driven in at right angles to them. As some convenient classification is desirable, however, the following gives for our common woodland trees and shrubs a rough general approximation, notwithstanding the great variations shown in different parts of the tree, and the disturbing and obscuring influence exerted by the fissibility or the apparent degree of hardness. *Very hard:* barberry, boxwood, privet, dogwood, hawthorn, blackthorn; *hard:* robinia, maple and sycamore, hornbeam, wild cherry, pedunculate oak, yew; *moderately hard:* ash, holly, plane, plum, sweet chestnut, elm, beech, sessile oak; and in minor degree, among conifers, the kinds having a distinct heartwood, larch, pines (though Weymouth pine is usually soft), and Douglas fir to a less extent; *soft:* horse-chestnut, alder, birch, hazel; spruces, silver firs, Thuja, hemlock, Weymouth pine,

juniper; *very soft:* all poplars, most willows, and lime; Sequoia, Cryptomeria. As a general rule, heavy kinds of wood are also usually hard; and for one and the same kind of wood, the hardness (as also the durability and the general quality) increases with the specific gravity and with the strength and cohesiveness of the woody fibres. In conifers, hardness is increased by the degree of resinousness, and this is especially the case when the annual rings are narrow. In trees the older wood is harder than the younger wood; and dry, well-seasoned wood is generally (though not always) harder than green, unseasoned timber — although hard and heavy woods like oak, beech, maple, and sycamore are easier to work when moist than when dry. Having special regard to sawing, where the saw acts at right angles to the run of the woody fibres, the hardest woods to work are the softwoods. Thus pines, spruces, and silver firs, which are not tough woods, are the easiest to saw; then come larch, oak, alder, maple, and sycamore; while the hardest of all in this respect are the tough softwoods, poplars, willows, lime, and birch, the sawdust from which is also more apt to clog the action of the saw. In felling with the axe, the apparent degree of hardness increases as the stroke approaches a direction at right angles to the run of the fibres; while the more obliquely the stroke is given, the less is the resistance offered by the fibres, owing to the cutting being then also to a slight extent combined with splitting, so that the ultimate effect appears to overcome the resistance better.

[J. N.]

Hardy Plants.—The term 'hardy' is of relative significance. A plant may be hardy in the warmer parts of the British Islands and require protection in the north and midlands. Or it may be hardy in a favoured position and suffer from cold in another position in even the same garden. Truly hardy plants in this country are those which live permanently in the open air in all parts, such as hawthorn, oak, willow, gorse, heather, cabbage, rhubarb, wheat, and clover. Other plants commonly accepted as hardy but which cannot bear this test are aucuba, peach, magnolia, hollyhock, &c. [W. W.]

Hare (order Rodentia; sub-order Duplicidentata; family Leporidæ).—The Brown Hare (*Lepus europæus*, Pallas), known in parts of Scotland and northern England as the Mawkin, is too well known to require detailed description. The usual weight of an adult female, which is somewhat larger than the male, is from 7 to 9 lb., but the average weight is higher in Scotland than in England. The heaviest hare on record was shot at Longwithen, near Morpeth, by Mr. Robert Henderson, and weighed 13½ lb. (Field, Oct. 28, 1876). In 1886 Mr. Millais shot three at Murthly weighing 11, 11¾, and 12 lb. The species is indigenous to the whole of Europe as far east as the Caucasus, except northern Russia, Scandinavia, Ireland, the western isles of Scotland, and Orkney and Shetland; but hares have been introduced and naturalized in nearly all these regions.

Unlike the blue hare, the brown hare never burrows, but couches in a well-defined bed or 'form' among heather, fern, or whins, on open pasture, bare fallows or ploughed land, or in woods. In all these varied positions the grizzled tint of the coat, caused by the grey under-fur showing through longer hairs of a ruddy tint, blends so closely with the environment as to require a practised eye to detect a hare in its form. The full, bright eye, with its yellow iris, is generally the feature that betrays the animal to untrained vision. Young hares are called leverets (= Old French *levrette*, from the Latin *lepus*, *leporis*).

The hare is crepuscular and nocturnal in habit, coming out to feed at dusk and returning to its form at dawn; but in spring, when the bucks are courting, they are active at all hours, following each other at a sober, meandering pace, occasionally interrupted by fierce encounters, whence the adage, 'mad as a March hare'. The female breeds during all summer, and late into autumn if the weather is mild, generally producing two to five in a litter, though in southern England as many as seven or eight are sometimes found. Three leverets is the commonest number of a litter; but the Rev. E. A. Woodruffe-Peacock writes: 'Every fœtal hare I have opened has held five young ones' (The Cultivation of the Common Hare, p. 7).

Hares, says Mr. Millais, are more fastidious in diet than rabbits (Mammals of Great Britain and Ireland, vol. iii, p. 7), but they eat large quantities of growing corn, sown grasses, and clover, compensating to some extent for the damage done to these crops by their partiality for dandelions, sow-thistles, and some other weeds. Turnips and mangolds are attacked also; but the work of hares on these roots may always be distinguished from that of rabbits, inasmuch as hares peel off the rind and leave it lying, whereas rabbits eat rind and all. They are very destructive to newly planted trees, and in hard weather will bark ash and beech trees of considerable size.

The flesh of the hare is brown and succulent; but it was forbidden under the Mosaic law because 'the hare cheweth the cud but divideth not the hoof' (Lev. xi. 6). This appears to be a mistake, arising from the habit of this animal of grinding its teeth when at rest, probably to keep them from growing too fast, as the teeth of all rodents have a tendency to do; but Mr. Drane of Cardiff, who has kept tame hares for many years and contributed much to our knowledge of the animal's habits, states that it makes an invariable practice of devouring its own excrement, even when plentifully supplied with its favourite food. He accounts for this by the hypothesis that during the night the hare crams its stomach with more food than can be digested in one operation, and nature, determined that 'nothing be lost', prompts the animal to pass it a second time over the digestive tract. Possibly this may be only a morbid action induced by confinement. Caesar states that the Druids would not eat the flesh of hares.

Hares have been highly prized as beasts of the chase in all ages. In this country they are hunted with harriers, coursed with greyhounds, and shot. During the first twenty years after

the passing of the Ground Game Act (1880), which conferred upon tenants an inalienable joint right with the landlord to hares and rabbits, hares diminished very much in numbers, becoming almost extinct in many districts; but of late they have been allowed to increase again in most counties, though not to the former excessive amount. Mr. Millais mentions that at Lynx Wood, near Newmarket, 680 hares were shot in one day, and 1600 in three days.

Subject to the tenant's joint right, hares are protected under the Game Laws, but there is no statutory close time for them in Great Britain, although, like other game, they may not be killed on Sundays or on Christmas Day, neither may they be exposed for sale from 1st March to 31st July inclusive. In Ireland the close time for hares extends from 21st April to 11th August inclusive, but the Lord-Lieutenant has power to alter these dates in different counties.

Hares are proverbially fleet, but the relative shortness of their fore legs disqualifies them from running downhill and from attaining their highest speed on the flat. When coursed by greyhounds, they invariably run up an incline if possible.

The Mountain or Blue Hare (*Lepus timidus*, Linn.) bears a general resemblance to the brown hare, but is somewhat smaller, its average weight not exceeding 7 lb. In colour it is very different from the other, the general hue in summer being brownish-grey, changing to slaty-grey in autumn and to pure-white in winter, the ear tips alone remaining black throughout the year. Its geographical range is greater than that of the brown hare, for it extends as far east as Japan, as far west as Iceland, and as far south as the Pyrenees. In North America its place is taken by a closely similar but somewhat larger species known as *Lepus arcticus*. Indigenous to the mountain ranges of Scotland, it may be looked for in the northern parts of that country on any uncultivated ground above 600 ft. altitude, and it has been successfully introduced to suitable parts of southern Scotland and of England and Wales. It is exceedingly numerous in the central Highlands, upwards of 1100 having been shot in one day on the high ground about Loch Ericht in 1896. Hybrids between blue and brown hares are not infrequent.

The blue hare burrows like a rabbit, but not so freely nor so deep, using such shelter chiefly as protection against its arch-enemy, the golden eagle. The female produces three to five leverets in a litter, and places them either in 'forms' on the open ground or among rocks. Heather, grass, rushes, and various kinds of moss form the staple diet of blue hares, and farmers have no reason to fear injury to arable land from them. The characteristic change of colour takes place in the hair of the animal, just as it does in the plumage of the ptarmigan, and is not wrought by shedding the old hair, as is the case with the American *Lepus arcticus*. The flesh of blue hares is not so highly esteemed by most people as that of brown hares, being somewhat more dry in texture, but it makes excellent stews or soup.

The native Irish hare was formerly distinguished by Yarrell and other naturalists as a distinct species under the title of *Lepus hibernicus*; but it is now classified as a sub-species or permanent variety of the blue hare, and named *Lepus timidus hibernicus*. It is slightly larger than the regular blue hare, having been known to attain a weight of 9 lb., and is redder in the coat. It does not change to white in winter so regularly as the blue hare, some individuals making a complete change, others becoming piebald, and others again making no change. There is a buff or yellow-coated variety which is said to retain the same colour throughout the year. Irish hares have been established in the Island of Mull, but other endeavours to introduce it to Great Britain do not appear to have succeeded. In habits they are identical with the blue hare, and are found in all the mountainous parts of Ireland, but are nowhere now very numerous.

[H. M.]

Harebell. — The Harebell or Bluebell of Scotland is known to botanists as *Campanula rotundiflora*. See CAMPANULA.

Harehunting. — Master Nicholas Cox, writing his Gentleman's Recreation before 1674, declares that 'of all chases the hare makes the greatest pastime and pleasure', and places it third in importance of beasts of the chase; although, he observes, 'by old foresters it is called the king of all beasts of venery'. Foxhunters sometimes speak with good-humoured contempt of harehunting as 'thistle-whipping'; but the popularity of the sport is attested by the fact that there existed at the close of the 19th century 119 packs of harriers and 48 packs of beagles in England and Wales, 2 packs of harriers in Scotland, and 28 in Ireland. No doubt these included several scratch packs; but on the other hand there are many old-established kennels where the breeding, feeding, and condition of the hounds have been as carefully attended to for generations as in any pack of foxhounds. But the expenses of a pack of harriers are far less than those necessary for hunting a country with foxhounds. Five-and-twenty couple of hounds suffice for hunting five days a fortnight; the master usually carries the horn himself, in which case he will only require two men to look after the pack—a whipper-in and a kennelman. There are no covers to be maintained, no earth-stopping to be done, no damages to game or poultry to be dealt with. While the master of foxhounds is a servant of the hunting public, the master of harriers is his own master, requiring only the goodwill of owners and occupiers over whose land he hunts. He is spared the difficulties which the foxhunter encounters with non-hunting owners about preserving foxes, for it is an old saying that the harehunter is best suited by the certainty of finding one hare and the chance of finding a second. Too many hares make hounds wild and careless, and they are continually changing from one to another.

Harriers of the oldfashioned breeds, viz. the southern hound, the rough-coated harrier, and the blue-mottled hound of the Weald of Sussex, are now seldom brought into the field. Packs usually consist of small thoroughbred foxhounds, standing 20 to 21 in. high. They are generally hunted in mixed packs, not, as in foxhunting,

in separate dog and bitch packs. Foxhounds, being more highly strung than regular harriers, require very quiet handling in the field, with sparing use of horn or voice. As the scent of the hare is much feebler than that of the fox, it is essential that the pack should be level, so as to carry a good head. The tendency of the hare is to run in wide circles round its native fields; it is only occasionally that she can be pressed out of her country and a good point-to-point run obtained. It is, therefore, of even greater importance than in foxhunting that hounds should not be pressed upon or ridden over. Where the master hunts the pack himself, and where considerable fields assemble, as often happens near large towns, a field-master should be appointed to keep order among the riders.

Beagles should not exceed 16 in. in height. The principles of hunting with them are similar to those with harriers, but their speed being much less, huntsman, whipper-in, and field should all be on foot. [H. M.]

Harelip, a malformation due to arrested development in the region of mouth and nostril. In the mammalian embryo an external fissure extends on each side from the corner of the mouth aperture to the nostril. In most cases, with the development of the nose and the upper lip, this fissure is quite closed up; but, as an abnormality, the connection may persist on one side or on both sides, and this is called harelip. The name obviously refers to the state of affairs normal in the hare (and a few other mammals) in which there is a median cleft extending through the upper lip to the nostrils. In some breeds of dogs the abnormality has become, so to speak, normal, and is associated with a split nose and a cleft palate. It seems that harelip in the embryo may be induced by a lack of nutritive power in the mother, and it is to be thought of as an arrest of development before the associated parts have attained their normal finished form. [J. A. T.]

Hares — Damage to Woodlands.— Hares (*Lepus timidus*) sometimes do a good deal of damage in nurseries and young coppices and plantations, more especially where fields are in the vicinity. But the injury is seldom concentrated like that done by rabbits, and it can easily be distinguished from this by the larger indentations. The trees chiefly attacked are soft or smooth-barked kinds, such as hazel, ash, maple, sycamore, Robinia, elm, and beech, while in orchards, apples are more attacked than the other fruit trees. The only method of adequately protecting nurseries and young plantations is wire-netting as required against rabbits. In the Scottish Highlands the Blue Hare (*L. variabilis*) can commit serious damage in young plantations during frosty weather when snow lies on the ground, unless prevented by wire-fencing. See also art. on GAME—DAMAGE TO WOODLANDS. [J. N.]

Harley, William (1765?-1830), a man of boundless resource and business enterprise. Born and bred in the country, he early conceived an attachment for agricultural pursuits, which he turned to such good account in after life. His first business was that of a weaver, the different branches of which he learnt at Kinross and Perth. Coming to Glasgow in 1789, he engaged in the cotton trade, in which industry he laid the foundations of a fortune which enabled him in 1810 to build the famous Harleian Dairy. His many public benefactions to the city of Glasgow—the supplying of the town with excellent spring water, the erection of baths, and the improvements which he effected in the baking trade—made him one of her most notable burghers. But it is as the founder of an improved system of dairying that he is chiefly notable to agriculturists. At this time milk was a luxury in Glasgow, and what was to be had was of very poor quality. Produced amid squalid surroundings and liberally adulterated with water it was almost unfit for human consumption. To supply the demand of an increasing population for new milk produced under sanitary conditions and at a reasonable price, Harley in 1810 erected the Willowbank Dairy. The first cow-house held 24 cows, but as the demand increased additional buildings were erected, till in the year 1814, 300 cows could be accommodated. At one period the stock actually amounted to 260 head. So admirably were the buildings constructed, so liberally were the cows fed and attended to, and so healthful were the surroundings, that the fame of this dairy spread all over Britain and Europe. It was visited by the most distinguished nobles and even European princes — the Emperor of Russia and his brother the Grand Duke Michael, Archdukes of Austria, and other German princes —flocked to see it. In arrangement, ventilation, lighting, and structural details the Harleian dairy was a model of perfection, and far surpassed anything of its kind in Europe. Regularity, order, and cleanliness were three indispensable requisites peremptorily insisted on by Harley. He demonstrated the success of the soiling system, kept a weekly record of each cow's milk, and also a rough record of the quality. In this respect his ideas were in advance of his time, but he showed very clearly that attention to such essential points was the basis of successful dairying. He may indeed be said to be the pioneer of the modern dairy industry. In 1829 he published a book, The Harleian Dairy System, in which he describes the buildings and the workings of his system. [R. H. L.]

Harness. — Harness is required for both light and heavy horses on the farm. In fact, where all kinds of farming are included there is a considerable range, as, apart from horses used for heavy farmwork and for the farmer's own use, there is light roadwork, such as milk carriage, fruit and vegetable conveyance, to be provided for. The outfit for horses used for heavy work varies somewhat in different districts. There are counties, especially where there is much heavy land, where the horses are still driven tandem or in single file in preference to the more ordinary pair abreast; and in some counties, especially where much woodland prevails, involving frequent hauling of timber and underwood, single-shaft wagons are practically always used to the exclusion of those with double

shafts. Local custom and tradition have an influence in the shape of some of the parts of harness, but in all there are not many pieces, the main ones being the bridle and reins, the collar and hames, and the saddle with attachments; or where chain work is done, no saddle, but in its place a back band and hip straps to carry the chains—though these are often not used in ordinary team work. The most important piece of harness is the collar, which should be well fitting and firmly but smoothly stuffed, otherwise shoulder galls and sore withers, rendering the horse temporarily unworkable, result. Many horses flinch in their draught and are shy pullers at a deadweight from habits contracted when wearing ill-fitting collars. If ill-fitting, it is difficult to fix the hames so as to place them in the proper line of draught. Collars should be fitted with a back loop at the top for attaching the crouper, and with straps to couple them with the saddle. In some districts rain shields—called 'housings'—are fitted to the collar and in some to the hames. Frequently these are used merely for ornament, but their real purpose should be to keep rain from getting between the collar and the horse's neck. Horses with shoulders liable to become wrung will often work best when fitted with a breast collar, and it is a wise precaution to keep one set in a stable in case of emergency, as it may frequently save a horse lying idle for a lengthened period. The hames (see HAMES) should be well-fitting and easy of adjustment. The cart-horse bridle is ordinarily simple, and almost always fitted with a strong snaffle bit and often with a bearing rein. The latter is often too tightly used, as horses are cramped from getting their weight into the collar, but its use is necessary on many occasions to keep horses from reaching after food or growing crops when it is desirable they should not do so. A leading rein or chap rein is necessary for leading. The saddle should be stoutly made, and mainly consists of a wooden tree or frame with a deep cross groove to hold the back band, to which a well-stuffed pad is attached; the saddle is sometimes covered with leather and sometimes not; the leather covering is more a matter of appearance than of real utility, and in some districts it is never seen, except perhaps for the head carter's team when taken out on the road. More important is a well-fitting and well-padded saddle, which will not injure the back or withers, and will keep the back band or chain from rasing the horse's side. For this purpose an iron ridget is separately placed over the saddle, suitable pieces of chain being attached to support the shafts. The crouper is attached to the saddle to enable the tail to keep the saddle from slipping forward; and this carries the breeching to enable the horse to shove back the wagon or cart, the stress of backing a load otherwise falling on the saddle. When horses are used for ploughing or other chainwork the saddle is ordinarily dispensed with, as is the crouper in many cases where the horses are worked abreast, the only support to the chains, apart from their connection with the hames, being a back band. The back band serves a good purpose in preventing the swing of the whipple-trees from wringing the horse's shoulders; but if most back bands are noticed when at work, it will be seen that they do practically little good, because they are too long to carry the chains, and are placed too forward. In fore-horse work, where long chains are necessary, and where a crouper is most commonly used, the hip straps do serviceable work; but it is more by way of safety, for there is not much chance of wringing the horse's shoulders when the line of draught is straight; but when pulling upwards, as when attached to heavy whipples, the weight has to be largely carried on the collar, much to the distress of the horse. In single-line work, when three horses are tandem the hind horse is commonly called the phill, thill, quiller, or coiler; the middle horse the body horse, and the front horse the fore-horse or leader. The chains for the body horse should be made so that there is a big link about 2 ft. 6 in. behind the collar, from which one chain leads to the body horse's collar, and one to which the fore-horse chains are hooked. If the fore horse is hooked close to the body horse's hames, the tendency is rather to pull its hames out of the collar than to assist draught. In a like manner the phill-horse chains should be provided with double ends if they are to be used with a fore horse. Harness being largely of leather should be kept well oiled, and repairs should be kept well up. It is a good practice to keep a hide of white leather to supply means for temporary repairs, but all harness should be overhauled by a harness maker once or twice a year; on large farms it is usual for the harness maker to visit the farm to make repairs twice a year. For light horse work, practically all the harness is of leather, leather traces taking the place of chains for draught. The quality of leather and the nature of the fittings largely regulate the cost. Inferior leather makes unsatisfactory harness, and poor harness is very dangerous. In purchasing harness it is advisable to go to makers of good repute. There are few districts where there are not makers who can be depended upon to supply good harness at a reasonable price. [W. J. M.]

Harness Horses.—The expression 'harness horse' is one that obviously applies to all animals which are used for the purposes of draught, and it is usual to divide them into two classes, namely, the light and the heavy, which in turn are subdivided according to their breeds. In this country the principal varieties of light harness horse are the Hackney, the Cleveland Bay, and the Yorkshire Coach-horse; the Shire horse, the Clydesdale, and the Suffolk being included in the list of heavy harness horses. Across the Atlantic the distinction drawn is different, as the Trotter and his immediate descendants compose the light-horse section, the Hackney being relegated to the heavy brigade. Regarding the light harness horses of the present day, there can be little doubt but that they are more bloodlike and elegant than those of a bygone period, the reason for this being that the roadways nowadays are far more level and easier for draught purposes than they used to be, whilst the vehicles which have to be drawn are very considerably lighter and easier to move.

Hence the horse-breeders of a century ago and more, commenced to appreciate the value of the Eastern blood which beyond all doubt flows in the veins of many a Hackney which traces his genealogy back to Flying Childers, whilst it is an indisputable fact that the Yorkshire Coacher owes his origin to a cross of thoroughbred and Cleveland Bay. With regard to the heavy harness breeds the case is quite different, for evidence in plenty is forthcoming to prove that they are at least as heavy again as were their ancestors; indeed, so far back as the days of King John, British monarchs interested themselves in the importation of large-sized stallions from the Continent—principally Flanders—their object being to increase the stature of the horses of this country.

It is, however, the light harness horse which has to be dealt with in the scope of this article, and such being the case, the decided opinion may be expressed that the Hackney above all other breeds is the one which is entitled to the most respect. His action alone would ensure this, but there are also such points as shape, make, carriage, and courage to gain him popularity. Up to a comparatively recent date, that is until about the early 'eighties, it was not customary to encourage the Hackney which exceeded 15 hands 2 in height, indeed the conditions of entry at the Royal Agricultural Society's Show debarred Hackneys exceeding that limit from competing. This obviously placed the breed at a disadvantage with the Cleveland Bay and Yorkshire Coach-horse; but a change in the regulations removed the cause of grievance, and now Hackneys of 16 hands are quite commonly met with, and frequently command sensational prices.

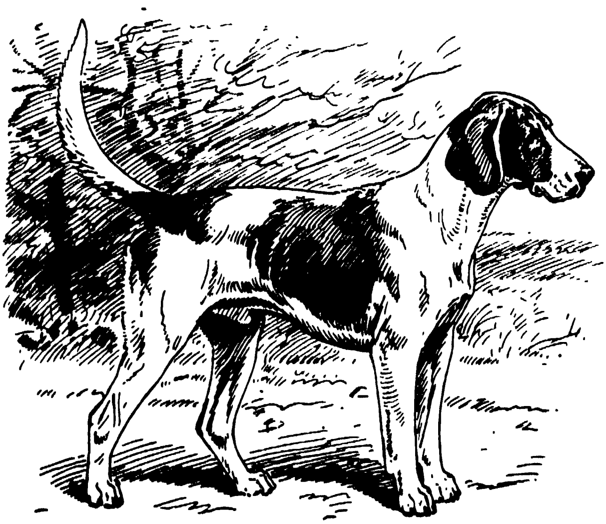
The great qualification of a high-class harness horse is action, as, without this, an animal, no matter how good-looking he may be, is not likely to be regarded as valuable. High, that is to say exaggerated, fore action, however, though essential to success in the show ring, is not usually associated with an ability to get through a great deal of work, as the feet and legs of a sensational mover must necessarily suffer from the effects of concussion if the horse is worked on a hard road. Many high movers, moreover, possess a bad hind action, owing to an inability to flex their hocks properly, and are thus decidedly inferior in their action. What is really required of a harness horse which is required for work, and is also desired to look well, is an all-round level mover, which uses shoulders, knees, pasterns, stifles, and hocks with some degree of uniformity, and so gets over the ground smoothly without injuring his hoofs, or pottering about with his knees almost up to his bit, and putting his feet down only a few inches in front of where he picked them up from. The head of a harness horse should be of medium strength, a very small head looking out of place when adorned with blinkers; the neck should be of fair length and not too heavy, and if the shoulders slope nicely the action will be easier than it would be otherwise, though for the purposes of heavy draught it is better that they should be, comparatively speaking, straight, as the short shoulder is usually the broader one and carries more muscle, which, though it reduces the speed of the horse, adds considerably to his power. The chest must be deep so as to provide plenty of room for the heart and lungs, and if speed is not essential it is better to be fairly broad, whilst the ribs must be well sprung behind the arms, the back short, the loins deep, and the quarters long and level, the tail being set on high, and carried a little up when the horse is set going. The fore legs should be short, with plenty of muscle on the arms, and heaps of nice flat bone below the knee, the fore feet being rather large and of the same size. The quarters should carry plenty of muscle, the back legs being rather bent at the stifles, with large, clean hocks. The latter ought not to turn either in or out, nor should they be too much bent, as if they are the propelling power of their owner is diminished. Colour, of course, is a matter of opinion, but for large carriage horses there are none to excel bay, brown, or black. Unfortunately of late years the vast majority of Hackneys are chestnuts, and hence many persons who would otherwise use them are reluctant to do so. The great foreign breeds of light harness horses, such as the Holsteins, Oldenburghs, and Frieslands, are mostly of good sound colours, and being for the most part good-looking horses with plenty of useful action, they are largely used for carriage purposes in this country. One more point about the harness horse must be alluded to, namely, manners, for unless a horse is good-tempered, well broken, and readily submits to the will of his driver, he is comparatively valueless, no matter how good-looking, or how fine a mover he may be. [V. S.]

Harpalus.—This name is applied to a large group of ground beetles. The mature insects prey upon other insects, and are also credited with injuring growing plants, such as the ears of corn, but of this there does not seem to be much proof. The presence of numbers of these beetles on cultivated land may only point to the opportunity given by the loose soil for the insects to hide away during the daytime, as they are nocturnal in their habits. It is well known that the beetles enlarge any small holes in root plants so as to get protection to themselves when resting; these holes admit moisture, and thus cause injury to the crop. The larvæ, on the other hand, are known to feed upon the roots of various plants. [J. J. F. X. K.]

Harrier.—It is not a very easy task to distinguish between some Harriers and some Foxhounds in the present day, owing to the fact that some old characteristics of the former breed have been lost entirely, and the recognized height considerably increased. A very conspicuous point of the Harrier of the past, namely, a rather heavy head, has almost entirely disappeared, and hence the similarity to the Foxhound which is apparent in some packs is very noticeable. That the two varieties possess a common origin is a matter upon which opinion can scarcely differ, as no doubt they both strain back to the old Southern hound of our forefathers, a most valuable hunting breed.

The increase of height in the Harrier, though

it may be regretted by some, is the result of the difference that exists, between now and the past, in the nature of some countries over which hares are hunted, as in some parts where the quarry is strong it is quite possible for a hare to run right away from an undersized pack, which could not go fast enough to keep within fields of her. It may be remarked, too, that it is by



Harrier

no means an uncommon occurrence for a pack of Harriers to be used in some countries for an occasional run after a fox, and hence once more the necessity for possessing hounds which can gallop.

The close connection which exists between the Foxhound and the Harrier does not necessitate an extensive description of the latter breed, as a reference to the description of the points of the Foxhound will convey the information required. At the same time it may be remarked that the Harrier still in many instances is a, comparatively speaking, heavier-headed hound than his bigger relative; whilst the fact that the old blue mottled colour is still recognized in his case, though it is not by any means so common as it used to be, provides another point of distinction between the two breeds. The average weight of a Harrier is about 55 lb., and about 22 in. is the average height. [v. s.]

Harrow. — Harrows are mainly surface-working implements, employed to produce a fine surface tilth and to cover seeds after sowing or drilling; they, however, perform other work, and there is a considerable number of different types constructed to do special work. So far as arable-land work is concerned they may be regarded as light cultivators with many tines, not provided with wheels. Cultivators practically always have wheels, and there are some implements to which the name harrow is applied which have wheels, which would be better described as cultivators, as they are used as cultivators to break up land to greater depth than is usually expected of a harrow. The frame of the ordinary seed harrow is now practically always made of iron, and is constructed so as to form diamond-shaped interspaces, the points where the bars cross being slotted to hold the tines, which also brace the frame. In this way no two tines follow exactly in the same place, and practically every portion of the surface is scratched. Usually three of these *zigzag harrows* are worked at once, being attached to a draught pole or bar on which is the draught chain to which the whipple-trees are hooked. These harrows are made in several sizes, from a light one-horse set for harrowing in small seeds, or for a last harrowing after other harrows, to heavy four-horse sets for pulling down coarse furrows on heavy land. *Wooden harrows* are fast disappearing, and in many districts have done so entirely, and it is certain that they are not so economical to work as are modern harrows. They remained popular on heavy clay soils because their weight tended to make them force their way into stiff furrows, but this is better done by sickle-tine cultivators or harrows. An exception in favour of wooden harrows may be made in respect to the use of very light sets for covering seed on light sandy soils, where lighter harrows than those made of iron are desirable; such harrows are found in Suffolk, where a set will cover a breadth of 20 ft. or more, and be easy work for two horses. As a rule, seed harrows have straight tines, as they

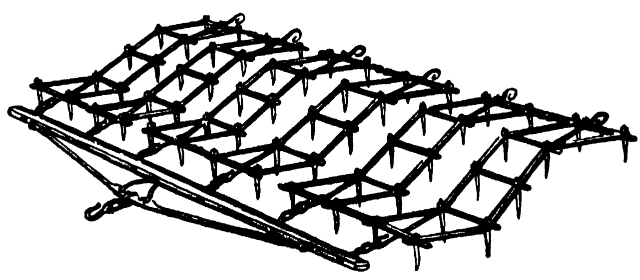


Fig. 1.—Zigzag Harrows

are wanted to smother the soil over the seed without disturbing it. Slightly curved tines are sometimes used on harrows to work land, but as they are short, and tend to make weeds collect and block against the frame, the straight ones, which are less liable to do so, are generally preferred. *Rotary harrows* are occasionally used, and work effectively. In these the frame is circular, and the draught is taken from a hinge working round a central vertical arm. A horizontal arm carrying an adjustable weight slightly

HARROWS

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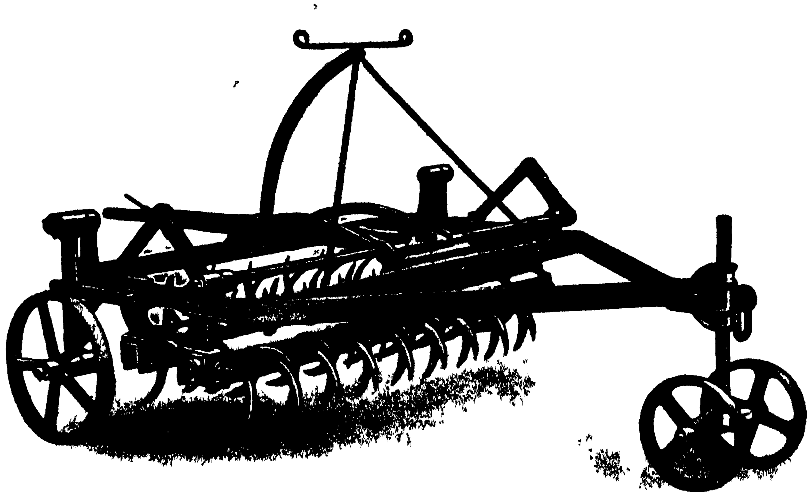

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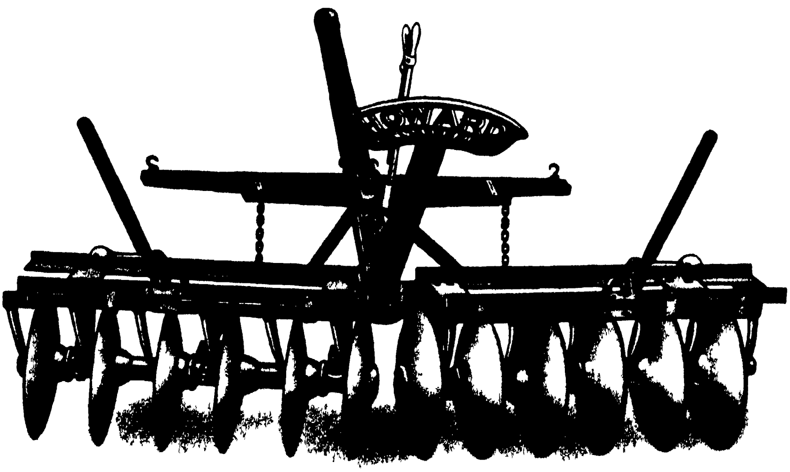

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1, Stanford's Norwegian Harrow 2 Howard's Disc Harrow. 3, Spring-Teeth Harrow

depresses one side of the harrow, thus impeding it, which with the forward motion from the

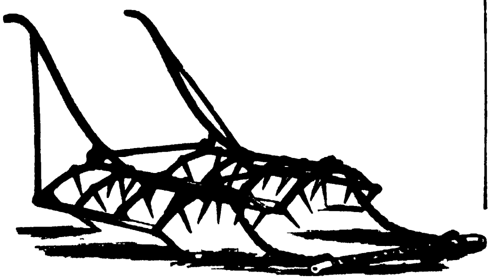


Fig. 2.—Drill or Saddle-shaped Harrow

horses causes the harrow to rotate, thus giving a lateral as well as a forward motion to the tines. Sometimes one large or two smaller harrows are used. In spite of the more thorough working, they have not come into general use. *Saddle-back harrows* are used for harrowing ridges laid up for potatoes or roots, to which their shape adapts them, and are very effective and in common use. The *Norwegian harrow* is practically a rotary cultivator: two spindles are mounted on a frame, and these each carry a drum into which are fixed a number of curved tines; the forward motion causes these to rotate, and in doing so they pierce the ground; the same harrowing thus gives a forking or combing treatment, lifting out couch or other weeds. As the two drums are placed sufficiently near for the tines on the hinder one to pass between the tines of the drum in front, the implement is self-cleaning. There are many good features in the Norwegian harrow, but it is not extensively used. *Sickle-tine harrows* are now made with slide guides or other adjustable contrivances for regulating the depth of cultivation.

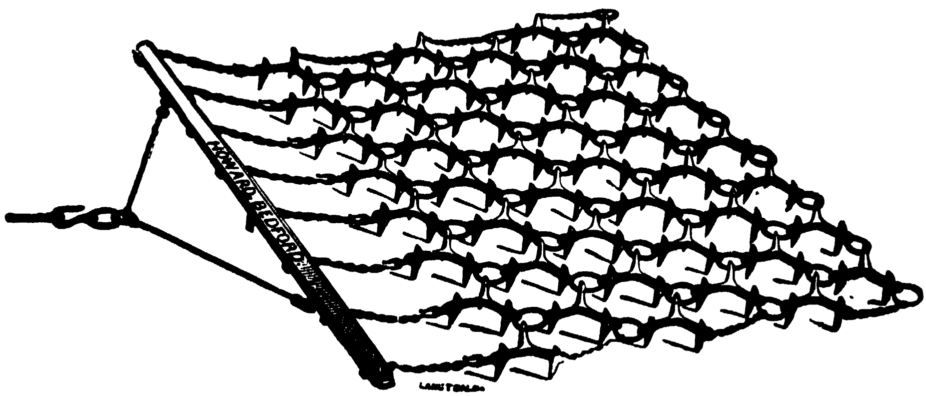


Fig. 3.—Howard's Flexible Grass Harrow. Can be worked either side up, to use the long or short points.

They are chiefly used for working down furrows, but are not well suited for covering seeds. *Flexible harrows* are now made in many forms, and there is a great increase in the extent of their use, especially on arable land. Being light and effective they are well suited to work down land, cover seed, collect couch, and destroy annual weeds such as charlock; moreover, they are effective grass harrows. This type is associated with Parmiter of Tisbury, who introduced them; they differ from flexible, chain, or link harrows in that they are provided with sharp cutting tines. *Steam harrows*, or harrows used in steam cultivating, are heavy, fitted with a stout frame, and are better suited for breaking down coarse furrows than for use as seed harrows. *Steam drag harrows* do the work of heavy horse cultivators. *Disk harrows*, very much used in the colonies, are becoming increasingly popular in Britain, and do excellent work when breaking up temporary or permanent pasture, as they cut the turves and masticate them. They are also suitable for working down land under ordinary conditions.

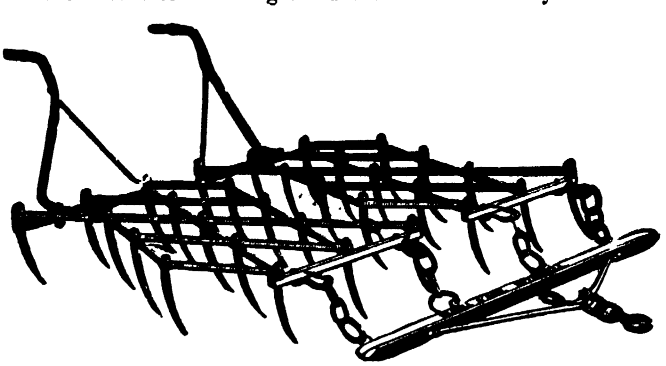


Fig 4.—Ball's Twitch or Drag Harrow

Drag harrows are stout cultivating harrows with curved tines, very commonly used. *Wheeled drag harrows* are light cultivators with numerous small curved tines. [W. J. M.]

Harrowing.—Harrowing is a mechanical form of raking, and is done to cover seeds, prepare seedbeds, loosen the surface when it is set too hard, destroy and collect weeds, and to surface-work pastures. There are many kinds of harrows (see HARROWS), enabling the farmer to make choice according to the nature of the work to be done, but the iron zigzag harrow is by far the most commonly used on arable land, as it is well suited to follow heavier cultivators in ordinary cleaning on seedbed preparing work, and works a good width with a moderate horse power; a set 9 ft. in width will work 1 ac. an hour on bad walking, 1½ ac. on fair walking, and on hard surfaces, as in harrowing wheat in spring, up to 2 ac. an hour. There is no hard-and-fast rule to regulate the number of times a harrow should be used, because soils differ, and conditions at the moment must decide. It is a good maxim, in working land from coarse condition to a seedbed, to let harrowings and rollings alternate; however, rolling may not be desired. Skill in directing harrowing is most required in the final workings after seeding, and skill is required to know whether a field should be left rolled down or be harrowed. Harrowing affords a great opportunity for controlling moisture, as by leaving the surface loose a mulch is formed, breaking the capillary action, and so leaving moisture about the seed or roots; but in certain conditions, as when the land is very dry, the land may be better rolled down to increase the capillarity and bring the moisture nearer the surface. Very often much of the labour expended in preparing a seedbed is wasted by injudicious rolling where harrowing would have been more suitable, and vice versa. It is to form a mulch and so control the moisture that wheat is harrowed in the spring. Flexible harrows are most suitable for grass harrowing, and it can scarcely be done to excess provided the weather is not frosty at the time. [W. J. M.]

Hartlib, Samuel, a prolific writer on agriculture in the middle of the 17th century, when he advocated and chronicled the many improvements in farming which had begun to be made on an extensive scale. He was the author of A Discourse of Husbandrie used in Brabant and Flanders; Samuel Hartlib, his Legacie, or an Enlargement of the Discourse of Husbandry; A Design for Plentie by an Universall Planting of Fruit Trees: and The Compleat Husbandman. These books were all published from 1650 to 1659, and all but the last in the three years ending with 1652. Hartlib persistently urged the desirability of growing roots for the folding of sheep after the Flanders manner, the general growth of clover and sainfoin, attention to gardening, and the planting of fruit trees. In his Legacie he set forth the advantages of using chalk, lime, marl, seaweed, fish, woollen rags, and poultry manure, as well as ordinary farm manure; he also recommended the ploughing in of green crops. [W. E. B.]

Harvest.—Using the term in a general sense, harvest includes the ingathering of all crops and fruits, and is therefore in progress during most of the year. It begins with the securing of such early hay crops as trefoil, trifolium, and clover, and is continued in the making and carting of meadow hay. This work is scarcely concluded before the earlier corn crops, such as rye and winter oats or barley, are ready for severance, and then comes the principal cereal harvest, which rolls northward from the south coast to remote Caithness, Shetland, and Orkney. The British corn harvest usually begins about the end of July, and is in full swing through August and September, but is not concluded in the far north until the end of October or later. After the corn harvest come the potato, fruit, hop, and rootcrops harvests, which last up to the end of November. The word 'harvest' is of Anglo-Saxon origin, and originally referred to corn alone. It has, however, obtained a wider meaning, and is applied to honey and other widely extended ingatherings, or even to realization in general. Up to the middle of last century, harvest was associated with the sickle and was an arduous task, involving much extra labour from Ireland and other thickly populated districts. Owing to the introduction of the self-binder, and the smaller area of corn grown, it is now much more easily performed. The custom of housing and feeding harvestmen, and supplying beer in the field, has passed away, and the harvesting of the corn crops now scarcely disturbs the routine of a farm, although it still continues to be the principal work of the year. [J. WR.]

Harvest Home and Harvest Customs, the festive celebration and its attendant ceremonies which from time immemorial have been associated with the successful completion of the grain harvest. Down to the middle of the 19th century the Harvest Home and other similar occasions of rejoicing—feasts, wakes, maypole dances, &c., were kept by the rural population with a heartiness which has now largely died away. The modern Harvest Festival is essentially a service of thanksgiving to God for the ingathering of the harvest, when places of worship in which such services are held are decorated with harvest produce, being thus quite different from the Harvest Home of former times. In Scotland the Harvest Home still goes under the old name of 'Kirn', being so-called because a churn full of cream formed an important part of the ceremony, but the wild frolic, drinking, and boisterous merriment, and general oblivion of rank and station with which the occasion was wont to be observed, have now been superseded by a becoming restraint and social decorum. In the north of England the Harvest Home is hailed under the designation of Mell Supper.

In the old simple days of England the Harvest Home was such a scene as Horace's friends might have expected to see at his Sabine farm. The grain last cut was brought home in its wagon called the 'hock' cart, surmounted by a presumable representation of the goddess Ceres, formed of a sheaf with gay dressings, while a pipe and tabor went merrily in front, and the harvesters tripped round singing appropriate songs.

"Harvest Home, Harvest Home,
We have ploughed, we have sowed,
We have reaped, we have mowed,
We have brought home every load,
Hip, hip, hip, Harvest Home."

In Scotland the last days of the cutting was marked by a contention on the part of the workmen in quickness of dispatch, groups of three or four each taking a ridge, and striving who would get it soonest cut. The last sheaf left on the field at inputting was trimmed up with ribbons, and decorated the festive board at night, and part of it was usually preserved in the farmer's parlour for the remainder of the year.

The hospitality of the oldfashioned harvest supper was a bond of union between farmers and their workmen of inestimable value, and a modified form of its observance should commend itself to the farmers of to-day. The farm labourer readily recognizes such an expression of goodwill on the part of his master, and in turn devotes himself with greater zeal to his master's interests. The spirit of commercialism, which is becoming more manifest under modern conditions of farming, is no doubt essential to success, but where it is evidenced in a mean, unsympathetic, and niggardly attitude towards the workmen, it defeats its aim, and results in that mere time and eye service which is becoming only too common. [J. H.]

Harvesting.—The first indication of harvest is the blanching or etiolation of the straw. It is a misfortune when this change takes place too rapidly, but it is watched with keen interest and some anxiety. The proper stage for cutting corn differs with the description of crop, oats and wheat being cut before they are dead-ripe, while barley is allowed to remain standing until the heads turn down and the grain is hard and wrinkled. As to the precise time of cutting wheat, it is now generally thought that early severance is best because the bran is thinner, the grain 'stronger' from the miller's point of view, the bushel heavier, the straw more nutritious for foddering, and the risk of blowing out lessened. It is also an advantage to clear stubbles as soon as possible, in order to prepare them for catch crops, for late turnips, or for autumn cultivation. It is, however, probable that the first four reasons given for early cutting may easily be abused, as they each point to the fact that the grain is not yet fully developed. Taking them *seriatim*, a thin bran may be an advantage, but bran is almost as valuable as wheat per ton, and is highly nutritious and easily separable from the flour. The 'strength' of wheat cut raw is due to the fact that the starch granules are not fully developed, and that consequently the gluten exists in a higher proportion, not because the grain contains more gluten, but because it contains less starch. The bushel is heavier because the grain is pinched and of smaller size; and finally the straw is more nutritious, partly because it still contains the elements of starch which ought to have passed into the grain. One of the best treatises ever written upon this subject is entitled A Bushel of Corn, by A. Stephen Wilson (David Douglas, Edinburgh, 1883). In this exhaustive work of 338 pages, the entire subject is closely discussed, and the conclusion is in favour of wheat being allowed to ripen. For practical purposes it may be cut as soon as the grain is firm and pasty without being hard, and the straw may at that stage still carry a tinge of green below the head. Oats also may be cut too soon, the consequence being a light bushel, and in black oats a red foxy colour. Oats are more subject to blow out than wheat, and this is a good reason for not delaying too long. Barley is preferred ripe by the maltsters, as it works kinder in malting, but in Bavaria it is cut earlier, when in the striped stage. The harvesting of all the cereals is now easily accomplished by the self-binder, which does the work rapidly, efficiently, and cheaply. The difference in cost is not so great as might be imagined, as the following will show:—

	s.	d.	
Self-binder with 4 horses worked alternately	5	2	per acre.
Self-binder with 6 horses worked alternately	5	8	,,
Reaping machine with 4 horses worked alternately	7	10½	,,
Reaping machine with 6 horses worked alternately	8	3½	,,
Mowing by hand about	12	0	,,

The advantages of machinery are therefore substantial from a pecuniary point of view. Horses in the above estimate are charged 2*s.* 6*d.* per day; but as they are not paid in cash like labourers, the amount of money which passes is very much smaller than when hand labour is employed. After severance, the corn is piled up in stooks or shocks and allowed to become thoroughly dry, and is then carted to the rick, and the total cost of the entire operation ought not to exceed 12*s.* per acre. The sickle is still used when crops are laid and twisted, and the cost of reaping is then about £1 per acre, while the total cost is fully double the above amount. The subject of harvesting is one upon which much might be written, especially as regards the difficulties which beset the farmer in unfavourable weather. The precautions taken to secure a uniform colour in barley, and the question as to whether it is better carried loose or bound by bands into sheaves, which is generally solved upon climatic peculiarities of the country or district in which the crop is situated; the hooding and protecting of stooks; the shifting of stooks to drier ground after rain; the use of ventilating shafts in ricks; artificial drying of straw; and other points, are all worthy of discussion. Among the most important changes in harvesting is the introduction of labour-saving appliances, the most important of which have already been discussed. Besides the various descriptions of reaping machines and binders, harvest operations are expedited by loaders, which carry the sheaves from the ground to the top of the load, and also by elevators, which carry them from the load to the summit of the rick. These are naturally better adapted for hay or loose corn than for bound sheaves, but they can be adapted to the latter. On the whole, corn harvest is less troublesome and less anxious

than hay harvest, as it takes more rain to stop operations in the corn than in the hay field, and wheat is often carried in a more or less damp condition rather than incur the risk of further exposure. Barley of all crops requires the greatest care in harvesting. In many of the best barley-growing districts it is carried loose after being turned several times. It is in this way kept more uniform in colour than when bound, but the latter practice spreads with the extending use of the self-binder. A little rain does barley good, as it enlarges the grain and makes it mellow. Great care is also necessary to cart barley dry, as otherwise it is liable to mould or heat, and contract a smell, and appearance known as 'mowburnt'.

The harvesting of pulse differs from that of corn crops. Peas are 'pulled' off the ground with a hook or sickle and laid in 'wads', which are turned until dry. A pea rick is particularly liable to injury from hasty rainfall, and ought to be thatched the moment it is topped up. Thatching is important in the case of all corn crops, and it is an axiom in harvesting that as soon as the builder leaves his rick, the thatcher should commence operations. Beans may be cut with the reaper or binder and tied up with string, or they may be cut with a strong hook and bound with straw. They are (except winter beans, which are early) the latest corn crop harvested, and will stand more bad weather without injury than the cereal crops. [J. WR.]

Harvesting Machinery. — Harvesting machinery now in use has greatly simplified the farmer's work, and his crops are now much more under his control than when he was entirely dependent upon manual labour for cutting and tying. He can with fewer hands get through now much more work in a given time than he was formerly able to do. The facility with which corn can be bound and stooked also tends to the safety of the crop during prolonged wet periods, as it is far less like to discolour or germinate, than when lying in contact with the ground. In view of the general use of the binder, it is difficult for those whose acquaintance with farming is recent to realize that about the year 1880 very few acres out of the millions grown yearly were cut by the binder in Britain, and that in the year 1860 the reaping machine was used so little that its influence on labour was practically inappreciable. The scythe and the hook may be required in the future as in the past, unlikely as it seems during favourable seasons. The binder has been the greatest of all labour savers in the harvest field, for it leaves nothing beyond the stooking or shocking to be done before the corn is fit to stack; yet there are districts where the self-delivery machine is still extensively used, and where the binding has to be done by hand, because there is a tendency on some soils for the crops to become so laid that the binder will not work effectively. In some seasons, when the crop is especially twisted, and where the crop lies flat in various directions, there are often pieces of some considerable size that require to be 'fetched' out so that the binder or self-delivery machine may be used; these may be too large for the scythe to be used profitably, in which case the manual delivery reaper worked by a single horse is a valuable aid. General as the use of the binder has become, the self-delivery and manual-delivery reapers are still of too much value to be allowed to become obsolete. Where the binder can be used there is little need for the horse rake, as few scattered ears are left on the ground; but where other means of cutting are employed there are sure to be sufficient trailed ears to make it worth while to rake. There is no machinery yet which meets one great need in the harvest field, that is, the pitching of sheaves or loose corn on carts or wagons. In the hayfield this need has been met; but the threshing out of the grain which would occur were the field hay elevator used prevents a similar machine from being used for loose corn; and necessity for the accurate building of the load has prevented the use of an elevator which will grip a whole shock or stook and deposit it on the wagon. Were a whole shock to be dumped on the wagon, the sheaves would be awkward to sort out and build. It does not seem impossible that a machine should be constructed to pick up sheaves laid in rows and put them on to the load, but nothing has been done which looks like being successful. The pitching of corn on to the wagon is practically all the manual work left in corn harvesting, for the stack elevator takes off the heavy work in stacking. [W. J. M.]

Hassock Grass, the name sometimes applied to *Aira cæspitosa* or Tufted Hair Grass. See AIRA.

Hatching.—This subject is fully dealt with under the heading INCUBATION, to which the reader is referred.

Hattock.—In wet districts, and especially in bad harvest weather, two sheaves are laid along the top of the stook to protect the grain from the effects of wet, and to keep the heads dry. Seed hay in the stook is similarly treated. A protected stook of this nature is called a hattock.

Haugh, a low-lying flat field adjoining a river and liable to be flooded. See ALLUVIUM AND ALLUVIAL SOILS.

Haulm, a general term applied to the straw of cereals, beans, or peas, or to the stems of the potato plant.

Hawfinch (*Coccothraustes vulgaris*). — This large resident finch (7 in. long) is chestnut-brown on the upper surface, with black markings on the face and throat, wings of purplish-black, and a certain amount of white in the tail. The large and powerful bluish or pinkish beak is distinctive. It is a woodland bird, and builds its large nest of twigs and roots, with a slight lining of hair, in the fork of a tree. The four to six greenish-blue eggs, streaked with olive-brown, are deposited in a rather shallow cavity. The Hawfinch chiefly feeds on berries and seeds (especially those of yew and hornbeam), and is also very fond of the kernels of stone-fruits (such as cherry) and of green peas. Although it also destroys cockchafers, caterpillars, and other insects, it is markedly harmful, especially to the market gardener and fruit grower, and

does not deserve the protection given to it by some of the county councils. The bird is common in many parts of Britain, and decidedly on the increase. [J. R. A. D.]

Hawfinch (*Coccothraustes vulgaris*)

Hawk.—In this country the term 'hawk' practically refers only to the Sparrow-hawk (*Accipiter nisus*), our commonest bird of prey, which is especially abundant in wooded districts. It is about 12 in. long, and characterized by comparatively short wings and long legs, as well as by the dashing nature of its flight. The reddish bars on the breast are also noticeable. The female is a good deal larger than the male. A large stick-nest, with scanty lining of vegetable fibre or moss, is constructed in the fork of a tree or among crags, or sometimes the deserted nest of a crow is appropriated. The three to six bluish-white eggs are blotched with red. Sparrow-hawks destroy large numbers of small birds, and as many of these are insectivorous, is thus indirectly harmful to agriculture. There can be no doubt that it is very destructive to game, and its raids on the poultry yard are well known. The available evidence, in fact, is decidedly against this bird. Opinion, however, is not unanimous, and further information, as in so many other cases, is greatly to be desired. Some of the small wild birds on which it preys are injurious to agriculture, and without extensive data we cannot say on which side the balance lies in this particular matter. In the meantime those interested in game and poultry are justified in keeping down the numbers of this bird, but the practice of waging a war of extermination on birds of prey in general cannot be too strongly deprecated. See FALCON and HAWKING. [J. R. A. D.]

Hawkbits are herbaceous perennial dicotyledonous weeds, common in meadows and pastures, belonging to the nat. ord. Compositæ, and to that division of the order with all the flowers in the head strap-shaped (ligulate). The plants closely resemble the common Dandelion, having a rosette of coarsely-toothed ground leaves, from the centre of which rises a leafless flower-stem (*scape peduncle*) bearing yellow flower heads. The seedlike fruit tapers off at the apex into a short stalk (*beak*) crowned with hairs, which are not simple as in Dandelion, but branched like a feather (*feathery pappus*). These feathery hairs act as a parachute, and facilitate the spread of the fruits by the wind. Hence, to prevent the spread of these weeds, the flower-heads should be cut off before the fruiting stage is reached. Two species are common:—

1. Rough Hawkbit (*Leontodon hispidus*, L.), with rough forked hairs. The simple flowering stem (*scape*) rises to a height of 6 or 12 in. and bears a single head of yellow flowers. For spreading by the wind, each fruit bears about a dozen brown feathery hairs, girt by five or six short bristles.

2. Autumn Hawkbit (*Leontodon autumnalis*, L.) is almost bald, and the flowering stem (*scape*) is scaly, usually bearing one or two branches. The hairs for spreading the fruit are brown feathers, but there are no surrounding bristles as in the former species. In habit, Autumn Hawkbit closely resembles Long-rooted Cat's Ear (*Hypochæris radicata*); when the flowers are pulled out of the head, the absence of chaffy scales (*paleæ*) marks the former species. See WEEDS, ERADICATION OF. [A. N. M'A.]

Hawking or **Falconry.**—The art of training birds of prey to the service of man was brought to perfection in very early times. Sir A. Layard found in the ruins of Khorsabad a sculpture representing a falconer with hawk on wrist, dating from about B.C. 1200. Pliny gives a detailed description of the method of hawking practised by the Thracians (Hist. Nat. l. x. c. 8), and the sport is frequently mentioned in early MSS. as being carried on in Great Britain during Anglo-Saxon times. With the advent of the Normans falconry was raised to the rank of a precise science, and throughout the age of chivalry remained the favourite pastime of knights and dames. It continued fashionable under the Stuart dynasty, but declined after the Civil wars of the 17th century. When Lord Orford revived the sport in the reign of George II he had to bring falconers from Holland. At his death his hawks were taken over by the Falconry Club, which continued till 1839, when, owing to the scarcity in England of kites and herons (the favourite quarry of falconers), the club transferred its headquarters to Holland under the name of the Loo Hawking Club. In 1853 it was dissolved, but was revived a few years later as the Old Hawking Club, which continues to this day under the presidency of the Hon. Gerald Lascelles. During all these years there have never been wanting private 'mews' (the technical name for a place where hawks are kept). The birds used in falconry are of two classes, viz.:—

True Falcons, or 'hawks of the lure', having a toothlike cusp on the upper beak or mandible, long pointed wings in which the second pen feather is the longest, and eyes with dark irides.	*True Hawks*, or 'hawks of the fist', having smooth mandibles, short rounded wings, the fourth pen feather being longest, and yellow or orange irides.

The chief species of falcon employed in Britain

are the peregrine, the gerfalcon, the merlin, and (rarely) the hobby. The first two of these are the more powerful, the 'passage hawk', 'haggard', or wild bird caught and reclaimed after maturity, making the bolder, stronger falcon, and is flown at herons, rooks, and other large quarry, known as *la haute volée*. The 'eyas', or bird taken from the nest and hand-reared, seldom equals the wild-caught bird in courage, and is flown at pigeons and small game. Of the short-winged hawks, only the goshawk and the sparrow-hawk need be taken into account. In both falcons and hawks the female bird is the larger and more powerful. In the peregrine, falconers reckon only the female as the falcon or falcon-gentle, the male being the tiercel. There are numerous treatises in many languages upon the management of hawks, the training of eyasses, and the reclamation of haggards or passage hawks, the standard English authority being Salvin and Brodrick's Falconry in the British Isles (revised in 1873). Young or freshly reclaimed hawks have bells and 'jesses' (strips of leather) permanently attached to their legs, a leash being run through swivels on the jesses. When a falcon is taken out it is blindfolded by a hood, which is slipped off before the flight, and is trained to come back to 'the lure'—a padded weight covered with feathers, baited with flesh, and too heavy for the bird to carry away. Short-winged hawks are not 'flown from the hood', which is only worn when travelling. The goshawk is a very powerful bird, and is chiefly flown upon hares and rabbits. The peregrine and the gerfalcon will only strike quarry on the wing. Originally devised by man as a means of obtaining food, falconry survives merely as a pastime; but it must always be regarded as a crowning example of the domination of man over the wildest of all animals. [H. M.]

Hawk's Beard, a genus of weeds belonging to the Compositæ, of wide distribution. See CREPIS.

Hawkweed.—The name given to a large genus of Composite plants, most of which are found as weeds on arable land. See HIERACIUM.

Hawthorn (Cratægus) is a profusely flowering and highly ornamental genus of the putaminiferous or drupaceous section of the Pomaceæ, which differs as regards its fruit from the pomiferous section to which the apple, pear, service tree, and rowan belong. There are many species of the genus Cratægus, and they are chiefly small deciduous trees or large shrubs, few of which attain a height of 30 ft. Only a few belong to Europe, while most of the others occur throughout North America and Central Asia. Only one species is indigenous to the British Isles, the Common Hawthorn, Hawtree, Quick, or Thorn (*C. Oxyacantha*), the well-known thorny shrub with glabrous and rather glossy, obovate-wedge-shaped, entire, trifid or cut leaves, which produces beautiful corymbs of several white or pinkish-white flowers in May (and in special profusion every alternate year), and whose scarlet-red haws ripening in September adorn every hedgerow. It is abundant throughout all northern Europe, whereas the other species occurring on the Continent (*C. monogyna*) is found more frequently in the southern countries; but they both occur in Russia, whence they extend into Central Asia, Syria, and Northern Africa. They are distinguishable by the Common Hawthorn being yellowish-green on the under surface of the leaves, and having the lower nerves always inclined inwards, whereas in *C. monogyna* the lower side of the leaves is bluish-green, and the lower nerves are curved outwards. Even in the woods the Hawthorn fails to be drawn up like a timber tree; and when growing isolated in parks, where it is very ornamental, especially on hillsides, it seldom attains a height of more than about 20 ft., but expands its crown of foliage and assumes the character of a large and spreading shrub. For park ornamentation the Pink Hawthorn (*C. O. rosea*), an artificial variety with beautiful bright-pink petals and white claws, affords a good contrast with the ordinary species. The Hawthorn shoots well from the stool, bears a considerable amount of shade, and forms a very hard wood; but it is of such slow growth as to be of little or no use in the coppices and underwoods. Its main use is for forming quick or live hedges, for which purpose no other plant is so suitable as this thorny, thick-growing shrub, for it has a strong power of shooting from adventitious buds on the branches as well as from the stool. It thrives best on a heavy, dry, loamy soil, and on lime or marl, but grows fairly well on a great variety of soils, and when properly tended and trained forms a thick hedge well resisting pressure; and on suitable soil it is one of our hardiest hedge plants. On light land it does not do so well as on stiff soil, and sometimes dies suddenly; hence it is there often mixed with beech, although this naturally weakens the hedge's usefulness as a fence for live stock in fields. By November the haws are thoroughly ripe for gathering for nursery purposes. To hasten the decomposition of the fleshy pulp surrounding the hard putamen, they are collected in a heap and mixed with an equal volume of fine sand; and this mass is turned over about once a fortnight till the second spring after gathering, when the clean seeds are sown on beds of good light mould. Thus haws collected in November, 1908, would be sown thinly in February or March, 1910, and lightly covered with about ½ in. of soil. The seedlings coming up are usually left two years in the seedbeds before being transplanted into the nursery lines, where they stand till put out as two-year-two-transplants. On the Continent the seeds are sown immediately after collection on seedbeds to which lime or marl is added, and then kept warm by covering the beds with dead leaves or pine sprays. Treated thus, many germinate during the first spring, though the bulk of the seed lies over till the second spring. Hawthorn should be well pruned at time of planting, as this stimulates its rate of growth at first; and when once a hedge has established itself, the more it is clipped the thicker it gets, and the better it acts as a fence. Ornamental varieties are propagated by grafting on stocks of the Common Hawthorn grown from seed. [J. N.]

Hawthorn. — Parasitic Fungi. — The

Hawthorn or Whitethorn is a host plant for several fungi parasitic on apple, pear, plum, and other Rosaceæ; hence the thorn hedge may be a source of infection for the more valuable fruit trees. Powdery Mildew (*Podosphæra oxyacanthæ*) is very common on hedgerows, appearing as a white dusty mould on leaves and young shoots; this fungus may be transmitted to apple, pear, cherry, and other species of Prunus and Pyrus (see APPLE—PARASITIC FUNGI). Cluster-cup Rust (*Gymnosporangium*) lives on hawthorn and other species of Cratægus, whence it may extend to fruit trees (see JUNIPER—PARASITIC FUNGI). Plum Leaf-blister (*Polystigma*) also occurs on hawthorn and blackthorn or sloe. *Treatment.*—Spraying with Bordeaux mixture (see FUNGICIDES) would check the above fungi, but the great extent of hawthorn hedges in many districts renders treatment difficult unless carried out on a large scale. If there is reason to suspect a hedge round a valuable orchard as a source of infection, probably the best plan is to replace it by wood or stone. [W. G. S.]

Hay, Composition of.—Hay, the air-dried produce of forage crops, forms, along with straw and 'roots', the staple winter fodder of the farm. Any green crop which, under ordinary climatic conditions, can have its water content reduced to about 15 per cent or less in a reasonably short time, may be converted into hay. The common hay crops may be grouped into the two classes of meadow hay and 'seeds' hay. Meadow hay consists chiefly of grasses, the proportion of leguminous plants being usually very low, unless the meadows have been liberally dressed with phosphatic and potassic manures. 'Seeds' hay varies in character according to the mixture sown, but consists mainly—very often entirely—of clovers and other leguminous plants.

The available information on the composition of British-grown hay is rather meagre, but the more comprehensive German data seem on the whole to be fairly applicable to our home-grown produce. The average compositions of a few typical kinds of hay as given by Kellner are reproduced in the accompanying table, with the addition of the 'starch values' for maintenance and productive purposes respectively. The data given for the digestibility of the two common classes of hay are rounded off from the averages quoted by Kellner.

	Moisture	Ash.	Albuminoids		Crude Fat (ether extract)	Soluble Carbohydrates	Crude Fibre.	Starch Values (i.e. weights of starch that are equivalent to 100 lb. hay of the composition given)	
			Crude (i.e. including amides)	Pure [1]				For maintenance [1]	For productive purposes.
Meadow and Grass Hay—	per cent.	per cent.	per cent	per cent.	per cent	per cent	per cent	lb	lb.
Meadow Hay, poor ..	14·3	5·0	7·5	6·6	1·5	38·2	33·5	39	18·9
" good ..	14·3	6·2	9·7	8·1	2·5	41·4	26·3	48	31·0
" excellent	16·0	7·7	13·5	10·8	3·0	40·4	19·3	55	40·6
" aftermath	14·8	8·4	11·5	10·2	3·4	39·4	22·5	51	35·7
Rye Grass Hay, English	14·3	6·5	10·2	8·4	2·7	36·1	30·2	42	22·5
" Italian	14·3	7·8	11·2	9·0	3·2	40·6	22·9	51	35·6
Timothy Hay	14·3	5·2	8·5	7·7	2·4	41·1	28·5	47	29·1
Leguminous Hay—									
Red Clover Hay, poor ..	15·0	5·1	11·1	9·4	2·1	37·8	28·9	44	25·2
" good .	16·5	6·0	13·5	10·5	2·9	37·1	24·0	49	31·9
" excellent	16·5	7·0	15·3	11·6	3·2	35·8	22·2	53	35·6
Lucerne Hay (cut before flowering)	16·0	7·3	16·2	12·2	2·4	31·1	27·0	47	26·5
Vetch Hay (cut before flowering) ..	16·7	9·3	19·8	15·5	2·8	28·5	23·4	50	30·4
Sainfoin Hay (cut before flowering) ..	15·8	6·7	15·4	12·3	3·2	34·0	24·9	51	32·9
DIGESTIBILITY									
Meadow Hay (medium quality) — Ruminants	(Mean of 38 samples)		60	—	50	65	60		
Meadow Hay (medium quality) — Horses	" 11 "		60	—	20	60	40		
Red Clover Hay (medium quality) — Ruminants	" 10 "		55	—	55	65	45		
Red Clover Hay (medium quality) — Horses	" 4 "		55	—	30	66	35		

[1] Not included in Kellner's Table.

It will be noted that, apart from the greater richness in albuminoids and the lower digestibility of the fibre in the case of the hay made from leguminous plants, the two classes of hay resemble each other closely.

The albuminoids in hay are always accompanied by appreciable amounts of amides, the proportion being greatest in the case of hay made from young plants. As a rule, about one-fifth of the nitrogen of the hay is present as amides. The 'crude fat' of hay contains little more than one-half its weight of real fat, and must be regarded as much inferior in feeding value to the fat of concentrated foods. The 'soluble carbohydrates' of hay consist chiefly of starch and cellulose, along with a little sugar, gums, &c., and considerable amounts of pentosans. Under this head are comprised also small quantities of volatile aromatic substances, notably coumarin, the ingredient which gives rise to the characteristic aroma of new-mown hay. The crude fibre also comprises a variety

of ingredients, the chief being cellulose, lignin, and cutin. The two last-named substances form the most indigestible portion of the fibre.

The ash of hay varies greatly in composition, but potash and lime are usually amongst the most abundant constituents, especially in the case of leguminous hay. The ash of grasses is further characterized by the presence of 15-25 per cent of silica.

The foregoing remarks are based upon the average composition of hay, but it must be borne in mind that, quite apart from the diverse nature of the plants of which it may be composed, hay varies in composition and nutritive value probably more than any other food.

The causes of these variations are numerous, and may conveniently be considered under three heads, corresponding to the three main periods in the history of the hay crop, viz. growth, haymaking, and storage.

(*a*) Factors Influencing the Composition of the Crop at the Time of Cutting.—The most important of these factors is the *age* of the plant. In general, the nutritive value of the dry matter of the common fodder plants steadily diminishes as growth progresses, this being largely due to the steady increase in the proportion and hardness of the fibrous ingredients. When seed formation begins, the more valuable nutrient materials are rapidly transferred to the developing seed, and the nutritive value of the leaves and stems sinks correspondingly, until, when the stage of complete ripeness is reached, they are to all intents and purposes simply straw. The commencement of seed formation is thus indicated as the limit beyond which, as a rule, the fodder crop intended for hay should not be allowed to grow. In the case of meadow hay, the greatest yield of digestible nutrients will, in general, be obtained by cutting the crop during the first half of the flowering period of the grasses. Once this period is passed, the digestibility, and consequently the nutritive value, of the fodder will sink rapidly. True, the stack may be larger for the delay, but it will consist not so much of meadow hay as 'meadow straw'. For the same reasons clover and similar crops should be cut for hay before the completion of flowering.

The influences of the *soil* and *manuring* on the composition of the fodder, although not so clearly defined as that of age, are nevertheless more evident in the case of hay than perhaps any other crop.

In general, the hay from light but moist soils is more nutritious than that from heavy soil. The latter, owing to the persistent wetness, and consequent coldness of the soil, usually consists to a large extent of the hardier coarse grasses of inferior flavour and digestibility. The same tendency to coarseness is always met with where the supply of water to the plants is excessive, *e.g.* sewage meadows, marshes, &c. On the other hand, undue dryness in the soil promotes lignification of the plant tissues, so that dry soils give, as a rule, a hard, difficultly digestible hay of low nutritive value.

The influence of manures on the quality of fodder crops is, in general, not very pronounced, except in so far as, on meadows, they affect the proportions in which different species of plants occur in the crop. This is well seen in the familiar effects of nitrogenous and of mineral (phosphatic and potassic) manures on the composition of the herbage of meadows, the former increasing the proportion of grasses, whilst the latter bring forward the clovers. Where heavy dressings of soluble nitrogenous manures are given, a more nitrogenous hay is obtained, but the increase is not so much albuminoid as amide in character.

The dominating factor influencing the amount, and also greatly affecting the composition, of the hay crop at the time of cutting is the climatic character of the *season*. In moist, warm seasons heavy crops of hay are obtained, but the plants are usually very watery, and, owing to their rapid growth, supply a much larger proportion of stem to leaf, and consequently a less nutritious hay, than in drier seasons. In a drier season the yield of hay is less, but it will be richer in albuminoids, and—unless prolonged drought occurs to cause extensive lignification—will also be more easily digested. Long-continued drought will, however, give stunted, small-leaved plants, which lignify quickly and may be very poor in mineral matter, notably lime and phosphoric acid. Cases of bone trouble in young stock have indeed been traced to this cause.

The best hay is obtained from sunny meadows with moist, but not wet, soil, in seasons of well-distributed medium rainfall. Such hay will consist largely of fine, tender plants, not necessarily rich in albuminoids, but with a low content of crude fibre.

(*b*) Influence of the Haymaking Process on the Composition of the Hay.—Under ideal conditions green fodder undergoes practically no change in haymaking beyond the reduction of its water content from about 80 to, say, 15 per cent. Such hay, except that it is somewhat less palatable and more difficult to masticate, is then practically as nutritious as the green fodder from which it is made. In actual practice, however, the conversion of green fodder into hay is always accompanied by some loss of nutritive matter. Thus, even under the most favourable conditions losses arise, partly from the continued respiration of the cut plants so long as they remain juicy, partly from fermentation, and partly from the breaking off of tender portions and seeds in the mechanical operations to which the hay is subjected. From 10 to 20 per cent of the dry matter of the green fodder may be lost in this way. The loss naturally increases the more prolonged the haymaking and the more frequently the hay is moved. It is thus greatest in the case of leguminous plants, since their thick stems dry slowly, and hence require frequent turning, so that loss of much leaf is difficult to avoid.

The mechanical losses in haymaking are trivial, however, in comparison with the loss that partly dried hay suffers on exposure to rain. So long as the plants remain in the green, juicy state, the rain does not penetrate them and no serious harm is done. Rain falling upon partly dried

hay, however, will rapidly wash out the soluble matters originally present, and subsequently also the soluble matters produced by the fermentation which goes on vigorously in the damp fodder. This fermentation also causes further loss in the form of carbonaceous gases, and if long continued, greatly detracts from the palatability and aroma of the hay. How great the loss may be in extreme cases may be seen from observations made by Emmerling (1888) in the case of meadow hay exposed in a thin layer in the field for twenty days, during which about 4 in. of rain fell. The percentage losses of the different ingredients were as follows:—

	Total Dry Matter.	Albuminoids.	Soluble Carbohydrates.	Fibre.	Ash.
	per cent.	per cent.	per cent.	per cent.	per cent.
First ten days	13·5	9·9	16·3	2·5	12·8
Whole period	46·1	45·8	46·6	27·7	48·6

Thus nearly one-half of the total nutritive matter originally present in the hay was lost in the three weeks, the losses falling in relatively equal proportions upon the albuminoids, carbohydrates, and mineral matter. The great wastage by fermentation is particularly apparent in the second half of the period, even the fibre being then greatly affected. The loss is, of course, all the more serious in that it is just the more valuable, easily digestible ingredients that are removed. The losses due to rain will naturally be less the smaller the surface exposed. Hence hay in cock suffers far less from rain than if left lying on the ground, whilst the circulation of air through the cock will still permit of slow drying.

When the climatic conditions are favourable for haymaking, little loss is occasioned by fermentation, since the activity of the bacteria, moulds, &c., is quickly reduced owing to the rapid drying of the plants.

(c) Changes in the Stack.—When the partly dried fodder is collected in stacks or barns, further drying can proceed only very slowly, so that a mild fermentation ('sweating') goes on for several weeks. This 'sweating' is accompanied by the evolution of a considerable amount of heat. Therefore, in addition to any still produced by continued activity of respiration in the vegetable cells, since, at the best, the circulation of air in the stack is very limited, the temperature rises, and fermentation is thereby still more favoured so long as a sufficient supply of moisture remains. This is notably the case with hay that has been stacked in damp condition. The temperature then steadily rises, and under favourable conditions may become so high that the hay is actually carbonized and may inflame when air is admitted. The bacterial fermentation to which the earlier stages of the heating are due cannot proceed at temperatures much above 160° F., so that the later and more serious stages of the heating must obviously be due to a direct oxidation of some ingredients of the hay. As to the nature of this oxidation we know as yet little or nothing.

When hay is stacked in rather damp condition there must always be the risk of 'firing', but it may be reduced either by mixing salt with the hay, and thereby checking the production of heat, or, better still, by ventilating the stack and thus facilitating the escape of heat by the circulation of air. Hay stacked in damp condition, however, is almost bound to deteriorate during 'sweating', owing to the excessive fermentation and development of moulds which invariably occur, and the consequent loss of flavour and aroma. Well-got hay commonly loses about 10 per cent in weight during the 'sweating' period, and shrinks in bulk to an even greater extent. Once the stack has settled down, the hay undergoes little further change, retaining its attractive appearance and aroma for very long periods. Gradually, however, the aroma disappears, the hay becomes brittle, dusty, and less palatable, and can then only be used satisfactorily along with other fodder.

No other food is so well suited as good meadow hay to serve as the chief or sole winter food of cattle, sheep, or horses. A certain amount of risk accompanies the use of new hay before it is thoroughly 'sweated'. This is probably attributable partly to the active fermentation occurring in it, and perhaps partly also to the presence of volatile irritant substances (*e.g.* formic acid), which are lost on exposure. For similar reasons, mouldy or otherwise damaged hay should be used with great caution, if fed at all.

Clover hay is, in the main, similar to meadow hay, but is richer in albuminoids, and its fibre is tougher in character. [C. C.]

Hay, Cultivation and Growth of.—The crops grown for hay in Britain consist either of grasses or clovers, or mixtures of these plants. The chief combinations grown are: (1) Mixtures of grasses such as are common on meadow land; (2) a mixture of Rye Grass and Clover; (3) Rye Grass alone; (4) Timothy alone; (5) Clovers alone; and (6) grasses suited for seed hay.

1. Mixtures of grasses which are grown for hay differ widely according to the soil, climate, seed sown, and manuring, and may be said to embrace in greater or less proportion all the perennial grasses and clovers. When grass seeds and clovers of various kinds are sown together, the crop is rarely if ever the same the first year after sowing, even where every variety is perennial. Soil and climate favour some and hamper others. Manuring has the same effect. Grazing and making into hay each exercise a favourable influence on some plants and a baneful effect on others, so that at various periods after a hay crop has been sown, the percentage of each variety of plants composing it, may vary greatly according to the treatment the crop has received.

Application of manures, such as nitrate of soda, sulphate of ammonia, or farmyard manure, in large quantity, will stimulate the stronger-growing grasses and prove hurtful to the clovers. If this treatment is continued for several years, the struggle for existence among the plants will become so great that only a very small number of varieties may remain. This is brought about not only by the effect of the manuring, but indirectly by the stronger plants overshadowing and crowding out the smaller ones, so that in the end only those survive which are best suited to the conditions to which they have been subjected.

This crop in some districts is annually cut for hay in the early part of the summer, and grazed during the remainder of the season, while in others it is grazed the one year and cut for hay the next. Under either set of conditions, where farmyard manure is available, no better, easier, or more economical method of applying it can be adopted than spreading the manure as soon as possible after the hay has been removed. If not done at this period, the next best time to apply the dung is early in autumn, say the end of August or September. If farmyard manure is put on at this season, all its soluble ingredients are washed into the soil by the autumn rains, and are at once taken hold of by the roots of crop. To no other crop, and at no other time of the year can farmyard manure be put on with less liability of loss, for little if any of the more soluble ingredients will escape being absorbed by the roots, while the less soluble parts will be taken up as they become available. Where hay is grown continuously, the land may be thus manured every alternate year with, say, 12 to 16 tons dung per acre, and the following year a mixture of two-thirds slag or superphosphate and one-third potash salts may be applied at the rate of from 4 cwt. to 6 cwt. per acre in autumn, and 1½ cwt. to 2 cwt. of nitrate of soda in spring. So treated, any properly seeded meadow may continue to carry good crops for almost an indefinite period. If the crop is grazed and made into hay alternately, the farmyard manure may be applied either after the hay crop is removed, or in the autumn of the year in which the crop is grazed.

The formation of such a meadow on arable land is a very important operation. The land should be clean and in good condition, and the seeds may be sown either along with the grain crop, or if so desired, by themselves. If sown with the grain crop, only two-thirds, or at most three-fourths, of the usual quantity of seed grain should be used, and great care should be taken to harrow the grass seeds well in, and roll the land immediately afterwards. If the land is infested with root weeds, or is overrun by such annual weeds as charlock, spurry, groundsel, &c., it should be cleaned in spring, and the grass seeds sown without a crop any time before the beginning of August. If the land is clean, or if there are only root weeds to contend with, the seeds may be sown in early spring; but if there are many annual weeds it is better to delay the seeding, and by repeated cultivating and harrowing the land to try and get as many as possible of the annual weed seeds to germinate, after which they may be easily exterminated. The permanent grass seeds may consist of—

10 lb.	Perennial Rye Grass	per acre.
4 ,,	Meadow Fescue	
4 ,,	Foxtail	
4 ,,	Golden Oat Grass	
4 ,,	Timothy	
2 ,,	Mixed Poas	
1 ,,	Dog's-tail	

It must be distinctly understood that pure germinating seed is meant here. Along with this may also be sown 6 lb. to 8 lb. of rapeseed, which with the young grasses will afford a considerable amount of sheep-feed in summer or autumn, according to the date when the crop is sown. This crop should always be eaten by sheep, but the stock should never be allowed to eat it very close to the ground. The consolidation of the surface by the feet of the sheep very materially assists in preventing the plants from being thrown out during a winter of severe frost. Such a crop should be manured in late autumn with 4 or 5 cwt. per acre of a mixture of superphosphates or slag, and potash, as already recommended, and with 1 to 1½ cwt. of nitrate of soda or sulphate of ammonia per acre in spring. In early autumn it should receive 15 to 18 tons of farmyard manure per acre, as finely divided and as uniformly spread as possible. The dung-spreading wagon is very suitable for this purpose.

In seeding such a crop there are various grasses quite good enough for other purposes which should *not* be included in the mixture. The chief are Cocksfoot, Italian and Annual Rye Grass. Cocksfoot ripens too early, and the seed-stalks are generally ripe before the other grasses have come to maturity. It is also inclined to grow in tufts where the crop is cut for hay, and in this way it smothers out the other grasses. The same applies to Italian, because it not only grows tufty, but it also dies during the second winter, leaving a large proportion of the land bare. Annual Rye Grass is not tufty, but it dies out too quick, and unless the land is highly fed, the ordinary perennial will die off in three or four years, its place generally being taken by weeds and the more worthless grasses.

2. Mixtures of Rye Grasses and Clovers are usually sown with a grain crop at the rate of from 1½ to 2 bus. per acre. The ordinary seeding of clovers is usually at the rate of from 6 to 8 lb. per acre, the varieties varying according to the purpose for which the crop is intended.

3. Ryegrass Hay.—Near most of the large cities, where hay is grown principally for sale, the seed sown is either all Italian, or has mixed with it Perennial or Annual Rye Grass to the extent of from one-fourth to one-third. With such a crop, as a rule only Red or Alsike Clover is sown. But there is here a difficulty in getting the clover to survive the first winter, and it has been found that Alsike often lives where Red Clover dies. If the crop is lightly eaten with sheep in autumn, both the clover and

Italian Rye Grass stand a severe winter better than when not eaten at all. Italian Rye Grass requires a heavy dressing of nitrogenous manures, and even on farms in good condition manurially, where such hay is grown for sale it is quite customary to apply from 1½ to 3 cwt. of nitrate of soda or its equivalent per acre in spring, with or without superphosphates and potash. If a second crop of hay is taken the same year, a manuring is given of 1½ to 2 cwt. of nitrate of soda or its equivalent, as soon as the first crop is removed. It is necessary to do this at the very earliest opportunity, as every day lost increases the risk of a deficient crop, and the plants, when exposed to the rays of a scorching sun without any stimulant, soon lose their power to produce a payable second crop. Where there is any difficulty in growing clover, the land should be freely manured with lime, slag, and potash before the seeds are sown.

Where intended to be seeded, Perennial Rye Grass should have very little clover sown along with it. Ryegrass seed is usually grown on heavy clay land which cannot be profitably green-cropped, and on such land clovers rarely grow well. This crop is harvested much the same as a grain crop. Particulars as to the cultivation and harvesting of Rye Grass for seed are given in section 6 below.

4. Timothy Hay.—In Scotland, Norway, and Canada a large proportion of the hay made in many districts is from Timothy alone or with the addition of a little clover. The clover, Red or Alsike, usually grows well enough the first year or two, but dies out quickly after that. The seed may be either sown with a grain crop or by itself. It succeeds best on deep free land, clay, or on moss. About 20 lb. of seed are usually sown to the acre, although many have equally good results from 12 to 15 lb. where sufficient care is taken to have the land in good order before the seed is sown. The surface should be harrowed as fine as possible, and then rolled before the seed is sown, after which it should be again harrowed and rolled. If there is any difficulty in getting a fine enough seedbed when sown along with the grain, the land should be summer-fallowed, and the seed sown without a grain crop, any time from June to August, during which time a good braird can usually be obtained, although it may be difficult to get such earlier in the year.

On heavy or deep lands judiciously manured, Timothy is almost a permanent crop, yet in the most of cases it pays to renew it when from five to eight years old. Where it is not desired to put the land under a regular rotation of cropping prior to again seeding with Timothy, it can be done by clearing the land in July or early in August, ploughing it, harrowing it thoroughly, and at once reseeding it. The crop next year will be a little late, and only a small one, but with judicious manuring it will thereafter do quite well. As soon as the first crop is removed the land should receive 16 to 20 tons of farmyard manure per acre, and the same each alternate year thereafter, while each intermediate year it should get 2 cwt. nitrate of soda per acre. Timothy is a gross feeder, and unless heavily manured it rarely gives a payable crop for very many years. [J. S.]

5. Red Clover is undoubtedly the principal source of clover hay as the term generally is understood. It is by far the most valuable plant of the clover tribe, and were it not for its liability to fail, it would probably stand alone as a source of hay of this class. Its leaves are of large size, conferring upon the plant the name of 'broad clover', and they are, besides, abundant and succulent. The stems are often spoken of as 'bone', and are thick, and furnished with stipules and leaf-stalks (petioles) which add to its substance. When cut at the proper stage it is highly nutritious, and when well secured it sinks into a compact truss of dark-brown colour, characteristic of clover hay; free from 'bents', and possessed of a rich aroma. Such hay commands a high price in the market, but it is not thought so suitable for horses as for cattle and sheep. Horses prefer a harder quality of hay, such as is found in mixed samples, or Rye Grass, and clover hay is too soft in its nature. The highly nitrogenous character of this class of hay need not be insisted upon here. This characteristic, however, affects its use, and should be remembered when it is used as a green food in combination with other highly nitrogenous foods. Clover hay is not suitable for ewes in lamb, on account of its heating nature. Its too free use has been known to cause inflammation of the uterus after lambing, and, later, of the mammary glands and teats. For this reason meadow hay is a much better food than clover hay for ewes before lambing; and the latter should be reserved until the critical period has passed, and the ewes are called upon to suckle strong lambs. It is well adapted for lambs, as young animals require albuminous food. It is, however, possible to go too far, and clover hay together with linseed cake, beans, and Swedish turnips may be the cause of what is known as 'albuminoid poisoning', which is shown in stiffness of the shoulders, and the animals becoming 'up' in the joints'. It would be a serious mistake to convey the impression that clover hay is a dangerous food for stock; but it may be well to remember that it is a rich food, and that a diet of clover hay, decorticated cotton cake, and swedes is very different from one of meadow hay, grass, and white turnips. The former would be unsuitable for in-lamb ewes, while the latter would be excellent for them. On the other hand, clover hay, cotton cake, and mangelwurzel, given judiciously, would be suitable for cows in milk, or for growing stock. A good albuminoid ratio is important, and an excess of albuminoids is wasteful or injurious; and it is in this connection that the high albuminoid ratio of clover hay should be impressed on readers.

Clover Hay differs in a marked degree from ordinary hay, and, in some important respects, from 'mixed hay'. It is the product of arable land, and in this respect resembles mixed hay; but, strictly speaking, it contains little or no Rye Grass, or grassy herbage of any kind, and

is composed, as its name implies, of the four clovers used in mixtures of seeds for mowing. Red and Alsike are the principal; but it must be allowed that Trefoil (*Medicago lupulina*), although not a true clover, is commonly grown for hay alone, and the product has every right to be named clover hay. It is of very excellent quality, being much finer in the stems than either Red or Alsike Clover, and is equal to them in feeding properties. Trefoil is frequently sown alone on chalky and calcareous soils like other clovers, and yields the earliest crop of hay of the summer, being often cut in May. It is less bulky, and lighter as a crop, than the other clovers named, but excels in the slender nature of its stalks, and its entire utility. A rick of trefoil hay is esteemed as of exceptional value by flockmasters, and is particularly suitable for lamb-keep. The only other clover which we need notice, before entering on the subject of clover hay as generally understood, is Trifolium or Crimson Clover, which is an esteemed fodder crop in the southern counties of England. It, however, is more suitable for folding green, than for converting into hay, as its stalks are liable to become coarse and hard, or what is graphically called 'sticky' (stick-like); and the foliage is also less abundant. It is only made into hay when the area grown exceeds the requirements of the flock for green food.

Alsike Clover, known botanically as *Trifolium hybridum*, is, as the name implies, of an intermediate character. It possesses greater permanence than Red, but less than White Clover; and in its flower and foliage it reminds the observer of both. It could not compete with Red Clover as a hay crop if it were not for its greater certainty; and it is principally as an assurance against clover failure that it takes the place of, or is mixed with, Red Clover. It is by no means so generally used, and is more frequent as an ingredient in mixtures of seeds than as a crop sown alone. It is often sown in clover-sick land. Viewed as a source of hay, it has many features in common with Red Clover, being broad-leaved and luxuriant; and its composition and properties are similar. As to differences indicated by analysis, they are scarcely trustworthy, as much depends upon the nature of the soil producing the plant, and the particular stage of growth in which the analysis is made.

So far as quality, or nutrient properties, are concerned, the two plants may be considered to be on a par; but both vary enormously with the soil on which they are grown, the stage at which they are cut, and the success with which they are secured. *Cæteris paribus*, it would be invidious to make any comparison detrimental to either one or the other, *i.e.* between a truss of Red Clover and one of Alsike Clover hay. Clover hay may be considered as differing from trefoil or trifolium hay, but can scarcely be further divided into Red Clover and Alsike hay. It is a matter of observation that live stock will decline to eat even these valuable plants when green if the herbage is sour, or gross, from some known or obscure cause. They will eat it down bare in some places, and absolutely decline to touch the same plants in others. Their choice is less limited when hay is supplied to them in winter, but the same differences must exist, and they certainly throw some light upon the real causes of one class of hay being superior to another. [J. WR.]

6. THE SEEDING OF HAY.—The only grasses grown by farmers for seed to any extent are Timothy and the Perennial and Italian Rye Grasses. The harvesting of Timothy seed in the United Kingdom is confined almost exclusively to Ayrshire, and more especially to the north of that county, in a district of which Kilmaurs may be regarded as the centre. In other counties an occasional attempt is made to save Timothy seed, but the amount raised is so trifling as to be negligible. Perennial Ryegrass seed production has been long associated with the methods of farming peculiar to North Ayrshire. On the stiff tilly soils characteristic of that district, the taking of a crop of Ryegrass seed is one of the outstanding features of the Ayrshire rotation, which consists of two white crops (oats) in succession, then two crops of hay in succession, followed by three years in pasture. The first hay crop is Perennial Rye Grass, which is seeded and threshed. In a lesser degree Perennial Rye Grass is also grown for seed in Lanarkshire and Aberdeenshire. Both Perennial and Italian Rye Grass are largely produced in the north of Ireland, chiefly in County Antrim and extensively around Lisburn and Ballymena, a common rotation in these districts being roots, oats, flax, *seeds*, pasture, oats. It is estimated that nearly twice as much Rye Grass is now saved in Ulster as in Ayrshire, with the result that in recent years there has been a downward tendency in prices for Ayrshire Rye Grass. Home-grown Italian is also produced to a small extent in Cambridgeshire and Westmorland. With the exceptions above noted, crops of Rye Grass intended for seeding are grown in the same rotation, and occupy the same position in the rotation, as an ordinary green-cut crop. Whether for green-cut or for seeding, Timothy is almost invariably grown in permanent meadow.

Occasionally Rye Grass is sown alone for the purpose of raising a seed crop; but it is more usual and a better practice, both from the point of view of maintaining soil fertility and increasing the nutritive value of the Rye Grass, which is considerably lessened by seeding, to include small quantities of Red, White, and Alsike Clovers also. On the very heavy class of soils Red Clover, of course, does not do well, and in these circumstances it may be replaced entirely by White and Alsike. The ordinary rate of seeding for Rye Grass is about 42 lb., or approximately 1½ bus. per acre, along with 8 or 10 lb. of clovers. For Timothy, see above. Other grasses may be included at the discretion of the grower, and taking into account the quality of the land. Some of the Ayrshire farmers favour the method of restricting the amount of Ryegrass seed and including several pounds of Timothy instead. In this way a moderate but satisfactory crop of Ryegrass seed may be ob-

tained, while in the following year a crop of green-cut Timothy may be taken, and good after-grazing is also ensured. For every pound of Timothy included, about three pounds of Rye Grass should be deducted. The seeds are sown in the usual way, and care should be taken to have the land clean. The presence of Yorkshire Fog, False Brome, and Hair Grass greatly diminishes the value of the produce.

No special system of manuring for seed production is followed, and any manure that is given should be in the main phosphatic in order to stimulate seed production. A mixture of about 3 cwt. of superphosphate, 1 cwt. sulphate of ammonia, and 2 cwt. of kainit, applied in spring when the grass is beginning to show some growth, would be advantageous in most cases. Under the Ayrshire system some farmers apply farmyard manure directly to the young seeds at any time during the winter. Others favour the practice of applying their farmyard manure on the hay stubbles after the seed crop has been removed. Cleaner seed is obtained by the latter method, which also repairs the exhaustion caused by the growth and removal of the seed hay, while the application directly to the seed crop of a large dressing of farmyard manure also tends to delay its ripening.

The crop of seed hay, whether it be Timothy or Rye Grass, is handled much in the same way as a cereal crop. Ryegrass hay is ready for cutting usually about the middle of July. The proper stage of ripeness is indicated by the seed breaking away readily when one or two ears are rubbed between the palms. The ears should be yellow, but a greenish tint should still remain in the straw. It is not an advantage to have it too ripe, or loss is liable to occur before the crop reaches the mill. On the other hand, it must not be cut while the seed is still in an immature condition. Timothy, however, should be thoroughly ripe before cutting—a condition which is seen in the tendency of the spikelets at the head of the stalk to peel off—otherwise it will not thresh out properly. About the middle of August is the usual time of harvesting Timothy seed. If the crop is short it is cut with the reaper, tied, and stooked, but if of a sufficient length it may be handled by the binder. If the seed is very ripe a loss is apt to occur during its passage through the binder, and trouble is sometimes experienced also with the hay choking the needle. Four or six sheaves are placed against one another to form a stook. When six sheaves are put into a stook, the centre pair often do not dry satisfactorily. The crop is allowed to stand several days in stook, after which the stooks are collected into 'rickles', or 'huts' as they are also termed, from twelve to sixteen stooks going to form one rickle. It is allowed to stand for a further period, depending upon its condition and the weather, before it is finally removed from the field. In Scotland the usual plan is to thresh directly out of the rickle, while in Ulster it is sometimes stacked and threshed out later. The former plan is perhaps the better one, both because the hay is rendered very brittle and practically useless by being stacked up with the seed and threshed in spring, and because the seed is more liable to heat in the stack than in the granary, where it can be turned frequently. Ryegrass hay also shrinks considerably in the sheaf, and trouble is often experienced with bands working loose. With the extra handling involved in stacking this trouble is aggravated, so that when the hay is being threshed out of the stack much of it is forked in a loose condition and a considerable loss of seed results. The case is otherwise with Timothy, which threshes out much more readily after it has been stacked for a time. After threshing, the seed is removed to the granary and spread out evenly on the floor. It should not be piled to a greater depth than 1 ft., and should be turned daily for a time to prevent heating.

The yield of Rye Grass varies from 1 to 2 tons of hay and from 4 to 8 cwt. of seed per acre. An average return might be put at 30 cwt. of hay and 5½ cwt. of seed. Of Timothy hay from 2 to 3 tons may be got with from 3 to 4 cwt. of seed. A crop of Ryegrass seed may realize anything from 8*s.* to 20*s.* per cwt., and 12*s.* may be taken as an average return. The price realized for Timothy seed varies considerably, but 45*s.* per cwt. is about the usual figure.

In arriving at any conclusion with regard to the relative economy of green-cutting and seeding hay, several factors have to be taken into consideration. Firstly, the expense of lifting, binding, stooking, rickling, and threshing is much greater than that involved in the operations necessary to secure a crop of green-cut hay, and whether this extra outlay will be commensurate with the sum realized for the seed depends very much upon the market price of the latter in any particular year. It must be remembered, however, that in the absence of green cropping the extra work involved in handling a seed crop simply serves to keep the workmen occupied at a time when they would otherwise have very little to engage them. A more serious objection to the practice of seeding Rye Grass is the fact that the quality of the pasture to follow is almost invariably depreciated. The Rye Grass is very liable to die out, and its place is taken largely by Yorkshire Fog and Crested Dog's-tail. Moreover, the aftermath from a seeded crop is greatly inferior to that following a crop of green-cut hay, while the threshed Rye Grass is itself of low value as fodder. The practice of seeding Rye Grass is very exhausting to the surface soil, and rapidly brings about a condition of poverty on all but the strongest class of soils if too freqnently repeated. [J. B.]

Hay Cocks, small conical heaps of hay, each containing from ½ to 1 cwt. of hay, which are made in the process of haymaking. See HAYMAKING.

Hay Collector, an implement for gathering in hay from the wind-rows. See HAYMAKING MACHINERY.

Hay Elevator.—This is a machine used in stacking hay. See HAYMAKING MACHINERY.

Hay Fork.—Hay forks can be made lightly, as they are not called upon to do the heavy work of digging or dung forks. They may be divided

into three classes, tedding or turning, emptying, and pitchforks. The tedding fork can be very light, and the tines be but little curved, as they are not required to hold much grass, and it is hindering if when turning, or when putting into wind-rows, the grass hangs about the tines. The emptying fork should be stouter, and with longer tines slightly more curved, and with longer handle or helve. The pitchfork is much bigger throughout, and must combine strength with lightness. They are made up to 9 ft. in length, tines 20 in. in length and 1 ft. span; the tines should have a good curve, as they hold more. Where hay is very short, as in some dry seasons, a fork of the above tine dimensions is apt to allow the finer grasses to slip through, and closer tines are more suitable. As a rule, the very biggest pitchforks are not the most convenient, and a handy man will do cleaner and better work with those of more moderate tine span. [W. J. M.]

Hay Holder.—Hay holders have become necessary in association with hay loaders, or field elevators, for lifting hay on to wagons or carts, because the elevator works only when the wagon or cart is in motion, and there is not merely difficulty in loading, but considerable risk that the men on the load may fall off. The hay holder is really a framework placed on the wagon or cart to retain the hay. Home-made ones of wood, forming flakes or hurdles, are not difficult to make. When used on a wagon the four corner poles can be used as supports, and the hurdles can be attached to them. It is customary and wise to make the side hurdles, or at any rate one of them, hinge, so that when feeding on to the stack elevator the load may be rolled into, and not have to be lifted over the hurdle. The back of the holder must not be too high for the field elevator to work clear, but the sides and front must be as high as desired. [W. J. M.]

Hay Kicker, a machine for 'working' hay when in the swathe. See HAYMAKING MACHINERY.

Hay Knife.—The hay knife consists of a stout broad blade with a right-angled cranked neck fitted to a stout wooden handle. The blade is not of equal depth throughout, but runs to a point to better pierce the solid hay in the stack; the face or cutting edge is of considerable curve, as in that form it presents a larger cutting area. Wavy-edged knives do good work, especially where the hay is not very solid. [W. J. M.]

Haymaking.—Haymaking is the process of cutting herbage of any sort, drying it in the sun, and storing it in stacks or sheds for fodder. It is one of the most important farming operations, and is practised in all countries where agriculture is known. Haymaking is not a very old institution in Great Britain, but it is now almost universal. Most of the labour is now done by machinery, though not very long ago the only tools used—apart from carts—were the scythe, the rake, and the pitchfork.

The proper time for cutting grass for hay is when the crop is just past the bloom and before the seeds have had time to ripen. If the seeds have become mature they will have withdrawn most of the food material from the stem and left it hard and wiry. The bloom of different grasses, of course, comes on at different times, but usually the first week of June onwards finds the crop ready for cutting in the south, while in the north the time may be postponed till July. Cutting is now done wholly by the mowing machine, which cuts a 'swathe' from 4 ft. to 6 ft. or even 8 ft. wide. The grass falls overlapped in these swathes in such a way as to shed off any slight rain. Before the advent of the mowing machine all the cutting was done by the scythe. This left the hay in long rows which were not shower-proof, so that they had to be 'tedded' or shaken out with the handfork for drying purposes. About 10 ac. per day is the common allowance for a man with a machine and a pair of horses to overtake; but much depends, of course, on the width of the cutting bar, the length of the day, and the condition of the crop—and the horses. With the oldfashioned hay scythe about 1½ ac. was a fair allowance per ten hours.

When the swathes have lain for perhaps a day in the sun with one side exposed, they are turned over to let the sun get at the other side. The grass has now lost its fresh green colour and has become a light grey-brown. The turning or tedding of the hay used to be done by hand labour with rakes, but is now done by machinery. This turning is the 'haymaking' proper. Nowadays we have a wide selection of swathe-turners, tedders, kickers, &c., all used in one way or another for turning over or shaking up the hay, so that it may become exposed to the sun and wind and so be 'made'. The modern swathe-turner is probably the best machine to use, as it is less liable to knock the leaves off the stuff or to break the stems. In the case of a thin crop, or when the sun is very hot, it is often quite unnecessary to turn the swathes, and many thousands of acres are cut and carried to the stack in the south country, without any 'making' at all.

The next operation is that of raking the hay into wind-rows by means of the horse rake. The horse rake is of two kinds—the ordinary one, which leaves the stuff in rows across the direction that it travels, and the side-delivery rake, which leaves it in rows parallel to the direction of travel. Horse raking is done generally up and down the line of the swathes, and the width of the rake is made to suit the width of the swathe. Generally two swathes are taken by the rake, but wider rakes taking four are in the market. The latter, however, are rather too much for one horse to pull, especially if ground is uneven. With a 9-ft. horse rake, 20 ac. can be raked into wind-rows in a day.

Hay in wind-rows is then 'cocked' or 'quiled' or 'coiled', that is, made into small conical heaps containing about ½ to 1 cwt. of hay each. Properly made cocks will stand the effects of rain for perhaps a week, only the outside straws becoming weathered. Cocking is an unnecessary operation when the weather holds fine, but it prevents the hay from becoming too much sun-bleached as well as wet-weathered. If the hay

is not cocked by hand, it can be pulled into heaps by means of the horse rake for convenience in handling afterwards.

Carting the hay to the stack was done by carts, till the introduction of the sweep rake largely superseded their use. It was the hardest part of the work, as the hay had to be lifted or pitched from the cock or rick on to the cart or wagon, and built on it. When carts or wagons are still used for carting, a hay loader is now generally employed. This is like a small elevator on two wheels, and as wide as a wagon, and coupled to the hind axle, and high enough to reach to the top of a load. As the wagon moves along the wind-rows the loader behind gathers the hay up with its revolving web, and deposits it in the wagon. A man on the wagon builds it into its place, and when his load is complete he unhitches the loader and drives to the stack. A man or boy is usually in attendance at the loader to couple it and uncouple it on to the wagon, and to lead the horses along the wind-rows.

The sweep rake is one of the best labour-saving machines that has been introduced for haymaking. It consists of a wooden framework 14 ft. wide on two wheels, with tines or fingers 10 ft. long and 18 in. apart fixed to the frame. The horses are yoked one at each side with pole straps to poles parallel to the tines at each side—outside the wheels—and pull from a whippletree attached to short poles level with the axle of the wheels. A triangular frame carried on a swivel wheel is hinged on behind, and carries a seat for the driver, and a screw wheel which depresses the points or tines on to the ground. The horseman drives his sweep rake so that the tines slip under the hay, and scoop it up whether it be in wind-rows, heaps, or cocks. A sweep rake will ordinarily hold two-thirds of a cartload. The poles prevent the hay from going over the sides on to the horses, and the frame at the back prevents it from going over there. The sweep rake when full is driven up to the stack and backed out, leaving the load lying on the ground. Of course this method of carrying hay can only be carried out when the stack is in the field, as the machine requires plenty of room, and when in work cannot go through an ordinary gate. Moreover, it is not desirable to drag hay along a dusty road. For convenience of transport the sweep rake is made to fold up at the hinges on the triangular frame, and the wheels are moved from their sockets outside the frame to others under the frame, which become upright when the tines are folded up. The sweep rake is now largely used in northern districts for dragging the cocks or hay in wind-rows up to the centres where the ricking or 'pyking' is being done in the field, and is a great advance on the old system of gathering with two horses hitched to a rope passed round the cocks, or the use of a plank and chains.

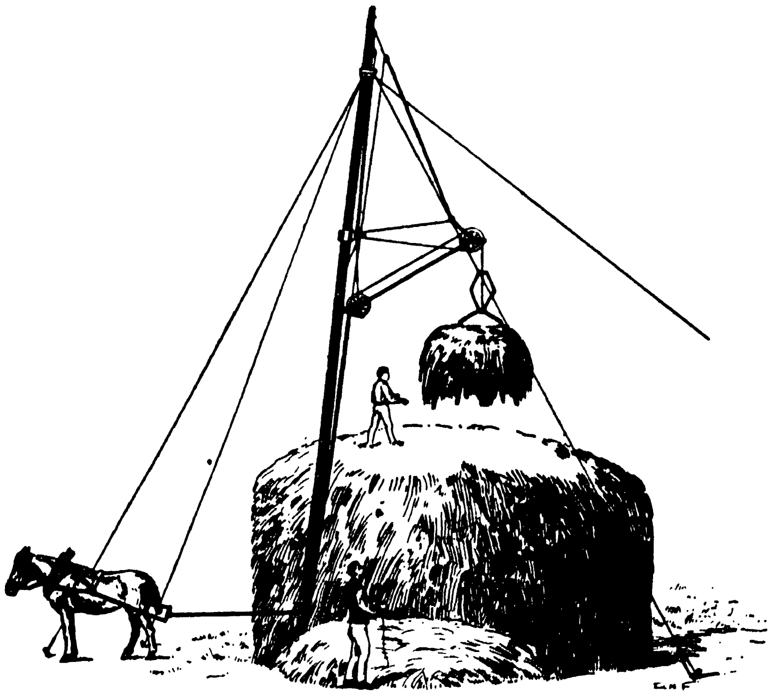


Fig. 1.—Horse Fork Elevator (Alex. Jack & Sons, Ltd.)

There are various methods of putting hay up on to a stack, the most primitive and laborious being that of pitching it all up with the hand-fork. But as time is valuable, some form of machinery is used, even on small farms. The cheapest and simplest form of stacking machinery is the horse fork. It is merely a form of crane, and consists of a long pole erected in the ground carrying a gaff. A rope works over the end of the gaff, with a horse at one end and a large iron grab at the other. This grab is lowered into the load of hay on the wagon drawn up next to the stack, the man on the wagon forcing the points of the grab into the load. The horse working the crane moves forward and raises the grab full of hay up on to the stack. The grab is provided with a patent catch which, when loosened, opens the tines and lets the hay fall out. This catch is operated automatically or by a cord from the ground. Horse forks are not very largely used in con-

junction with the sweep rake, as the hay in a sweep load is not in such a compact form as on a wagon where it has been built, consequently the grab cannot get such a big load and time is lost.

The stacking elevator is the best machine for stacking hay. It consists of a long trough, 4 ft. wide and 40 ft. long, on wheels. The lower end of this trough is hinged on to the frame, and the other end is raised or lowered by chains over poles fixed at the other end of the frame to suit the height of the stack. An endless web of spikes revolves in the trough (worked by a pony gear). The hay placed in the trough at the bottom is carried upward on this endless web and dropped on the stack. An elevator is convenient but expensive, and hence as a rule is only used on farms where a lot of hay is to be handled. See ELEVATOR.

In the north of England, Scotland, and Ireland, where the climate is humid and the weather generally damp, the hay is not carted directly from the field into the stack. When 'made' fit to stack, it is first built up into little ricks or 'pykes' in the field, each containing about 10 to 15 cwt. As soon as it is in these it is practically safe for a while, and it is often several weeks before it is put into the large stack at the homestead. The reason for this method is that the hay in these localities consists of softer grasses, which take more curing in the sun, and as there is less sunshine to depend on to thoroughly make the hay, it has to a large extent to cure itself when in the field rick. On the other hand, if it were stacked right away in a large stack it would heat or rot.

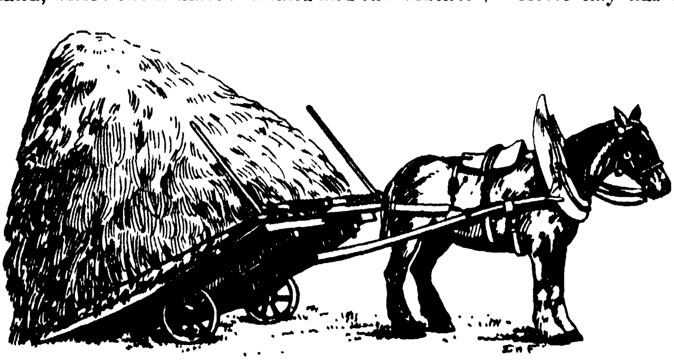


Fig 2. - Hay Rick Lifter (Alex. Jack & Sons, Ltd.)

Stacking the hay from the field-ricks is done at any convenient time so long as it is dry overhead. Loading from the rick into the cart requires the strongest man on the farm, for the hay has, of course, settled down, and is very solid to move. To save the labour of having thus to pitch the hay twice, an implement called a rick lifter is used, which is merely a very low cart without sides and drawn by a horse. This is backed against the rick, and the end of it tipped on to the ground against the bottom of the rick. The lifter is provided with a windlass, and a rope or chain is put round the base of the rick and wound up, and as it tightens the hay slides on to the platform, which is then brought back to the level and is taken to the stack.

Another method of loading these ricks on to carts is by means of a pulley and tackle on three shear legs on wheels. These shear legs are drawn by a horse and placed over the rick. A tackle is fixed round and below the hay, and the horse pulls on this and raises the rick up high enough to allow a cart to come underneath and receive the whole body, which is then lowered on to it. By these two methods the double labour of pitching the hay on to the cart from the rick is avoided.

When the hay has experienced an excessive amount of adverse weather before being stacked, it is a good plan to sprinkle some common coarse salt or special hay spice on every layer as it is built up. This often helps to keep away a musty flavour.

After hay has been 'made' in the field, and carried from the cocks or field ricks to the stack at the homestead, the next process takes place. This is the heating or 'sweating' of the body of the same in the stack. In northern and humid districts this must have largely taken place in the field rick as a preliminary, but in the sunnier south of England, where the stuff is stacked up direct from the swathe or wind-row, the process must take place in the stack. In a closed body like a stack the heat will accumulate till harm may be done. The object of the skilled haymaker, therefore, is to have his hay at just such a state of dryness that the initial stages of heating only are reached. Fermentation takes place, whereby the starch in the cells is converted into sugar, at which stage we wish the process to stop. If overheating takes place the sugar changes into the next stage—alcohol—and then into acetic acid (as we see in the formation of 'sour' silage). In a stack the intermediate body, acetic aldehyde — a suffocating and inflammable gas — is formed, and from this spontaneous combustion is liable to result in the dry south country. The chemical action is not very well understood: the life action of the protoplasm of the cell tissues would be killed when a temperature of 160° F. is reached, and beyond this the heating and firing must be due to chemical action alone. The danger zone of a stack is of course in the middle part, and about 6 ft. from the ground. Below this, the superincumbent weight of the hay squeezes out the air and prevents fermentation, while above and around this the heated air escapes to the outside. In the humid north there is not the same danger of heating resulting in firing, probably because of the naturally damper nature of the stuff. But there may be a development of fungoid growths, such as *mucor*, *aspergillus*, &c., resulting in mustiness, and even rotting in extreme

cases. The whole skill and judgment of the haymaker, therefore, either north or south, is directed to getting his stuff to just that stage of dryness that when stacked up it will neither become brown nor black from carbonization due to excessive heating, with the danger of spontaneous combustion, nor yet musty and mouldy, but remain at the initial stage of change, with as much green or grey colour left as possible. Dry sunny weather is necessary to attain this, and therefore rain or even dull weather is fatal to the production of good stuff. A wet haymaking time — like a wet harvest time — is a miserable experience for the farmer.

When once hay has been got up into the stack, the stack should be trimmed and 'topped up' the second time as soon as it has settled down, and then thatched, so that rain may not penetrate, and spoil a lot of the stuff after saving. During the building of a large stack it is necessary to have stack cloths or sheets at hand to cover the open tops temporarily during night or in wet weather, so as to protect from damage.

The method of marketing hay depends very much on local customs. In some cases the hay out of a stack is loaded up on a long-bodied cart in a loose condition and tied on with ropes; in other cases it is 'baled', that is, the hay is filled into a machine consisting of a box with a compressible lid, worked by levers, where the hay is squeezed into a cubical block containing 1 to 2 cwt., and held together with cord tied round it—much of the foreign hay being delivered in this form, but tied with wire in place of cord. In the London and other southern markets the hay is cut out with a hay knife in solid cubes about 3 ft. by 2 ft., and of a thickness to weigh ½ cwt., and tied with two straw bands. This forms a 'truss', and thirty-six of these constitute a 'load' (*i.e.* 18 cwt.), which is the unit for sale purposes. Sometimes these trusses are pressed in a machine and tied with three cords so as to occupy less room, and 'pressed' hay is carried at a lower rate of carriage.

These methods all depend on the local market customs, but the system of cutting out into trusses and tying with two straw bands is so tidy and convenient that many farmers follow this plan with the hay they use at home, as it enables them to measure it out to stock very accurately, and there is no waste from loose handling.

In the above article it has been assumed that grasses and clovers are the plants devoted to haymaking purposes, as the greater part of the hay made in this country is derived from these. There are many other crops, however, which can be utilized in the same way, such as tares, lucerne, sainfoin, &c. Even a corn crop can be cut green, dried, and stacked up as hay, and it is a common practice to make any kind of forage into hay if not fed green. Each kind of stuff requires slight modifications in handling: rye grass will dry easily and quickly and keep well in the stack, meadow hay will come next in order, while clover is much more difficult to 'make'. Such crops as lucerne and tares are the most difficult to 'make' of all, and it is only in the drier districts of the south that these are grown as hay crops, while the time of working is adapted to the driest time in summer as far as possible. [P. M'C.]

Haymaking Machinery. — The introduction of machinery has made haymaking very simple and inexpensive in comparison with what it was when all the work was done by hand; moreover, the new kinds of machinery brought out in recent years have greatly reduced the cost of haymaking. Now, very little manual labour is required in the hayfield, and hay is far better made than it used to be, except in the districts where special pains were taken to produce the best quality. In many districts the process of haymaking had degenerated into a very slipshod and unsatisfactory condition, partly because of the difficulty in getting manual labour, and partly because since 1887 there have been few years when haymaking has caused much anxiety, as dry summers have been unusually prevalent, contrasting greatly with those in the previous ten years. Haymaking in these districts consisted of little more than cutting the grass, allowing it to bake dry on the top and less dry below, and then collecting with a horse rake and carting it to the stack. In this way the upper portion of the swathe was overdried, while the under part was often mouldy from long contact with the ground when in a wet state, and mouldy stacks were very frequent. The introduction of the swathe turner and the abolition of tedding have made it inexcusable to spoil fodder in this way. It is only by bad management, even in 'catchy' weather, that any very serious loss of hay need be incurred; for with such quick and inexpensive means of drying the grass, together with the control a farmer has in respect to the cutting, now that the mowing machine is practically universally used, there is no need to have any great quantity of grass lying at risk. The principle of the haymakers in Middlesex, which prevailed even before Middleton wrote his description of the process more than a century ago, was to cut only such as could be kept under control with but little risk of injury. The introduction of the mowing machine, and the ease with which a large quantity could be cut, tended to make many cut far more grass than the machinery available could control, in the event of showery weather setting in; especially as the haymaker or hay tedder was used to throw it broadcast, where it lay, at greatest risk of injury in prolonged wet. In exceptionally fine seasons, injury by wet was not experienced; but the British summer has proved too variable for such risks to be taken with impunity, so when a wet season came, many were found with their crops rapidly spoiling, and lamentations were loud. With the modern swathe turner, collector, and field hay loader there is now an equivalent of afterwork machinery which places the making on an equality with the rapid cutting of the mowing machine.

Mowing Machines.—The scythe, which was the universal grass cutter, is now only occasionally used, as where the crop is very badly twisted, or where the inequalities of the ground do not permit the use of the machine. It was urged

during the earlier days of the general use of the mowing machine that the pinching of the scissor-like action of the mowing machine caused subsequent deterioration of the pastures, whereas the clean knifelike cut of the scythe produced no injury to them. This is rarely mentioned now, and there is no reason to suppose that the scythe has any preference in this respect. The thicker swathe, owing to the wider stroke of the scythe, renders it more difficult to 'make' the hay than where the thinner swath of the mower has to be dealt with. The scythe may, however, sometimes be used with advantage when cutting ripe clover seed, as the jarring is less, and the 'heads' are better laid to be handled.

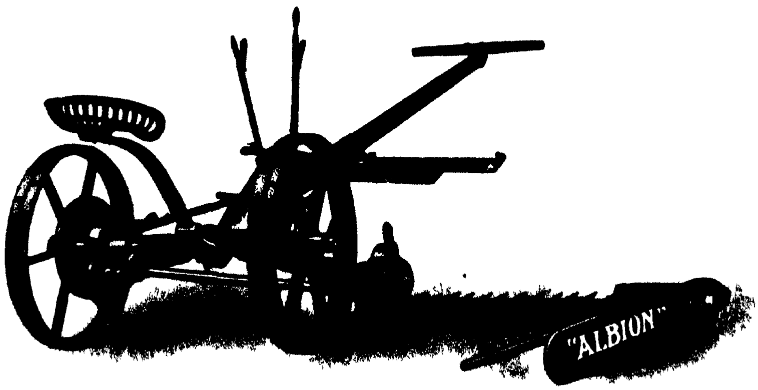
The *mower* has been subjected to little alteration for some years, and whilst the reciprocating knife passing through a series of slotted fingers is used, there is little likelihood of much change being made. Whether any other form of cutting will ever be found to supersede it is doubtful, though not impossible; for, excellent as the work is, there is the objection that the fingers are somewhat given to block sufficiently to make the knives run hard. The mower frame is always carried on a pair of driving wheels, whereas now practically all corn-cutting and binding machines are carried on one driving wheel. The binder machine is kept balanced by a small travelling wheel on the other side of the platform, the platform and frame being rigidly attached; in the mower the cutter bar carrying the knife is loosely hinged to the frame so as to give it freedom to rise and fall with the inequalities of the surface, therefore two travelling wheels are required to balance it. As the wheels are ordinarily both used for driving purposes, and as at the ends, or when working on crooked sides, these two wheels do not travel at the same pace, and as it is necessary that the knives are kept cutting to clear their way, each one is fitted with a ratchet. The motion of the knife is imparted from the travelling wheel by a rim gear, a nave gear, or an axle gear, some makers preferring one and some another; and as grass land rarely 'licks up' as does arable land when wet, the objection to the rim gear does not obtain with the mower as it does with corn-harvesting machines, where the gear is liable to block with mud. Whichever gear is adopted, the aim is to get the connecting-rod to drive as nearly as possible in a line with the cutter bar. Modern machines are fitted with suitable levers to allow the knives to be quickly raised away from antheaps or other obstacles which may suddenly appear in the track; also to alter the pitch of the knives, by changing the relative position of the draught pole to the frame. Ordinarily, mowing machines are not fitted with a revolving reel to bring the grass to the knives, and to keep them clear so that they do not cut the grass again and again. These are used on all corn binders. The difficulty of working the reel from the ordinary gearing of the mower is the reason; and it is due to the fact that the frame and the cutter bar work independently. It was solved by Saunderson, of Bedford, who obtained the Royal Agricultural Society's medal at Leicester for a *mower reel* worked by an independent travelling wheel attached to the driving pole, thus obtaining the motion required. This can be attached to any mowing machine, and is adjustable to any crop, short or tall, whether standing upright or leaning away from the advancing knives. Considerably lower cut is thus obtained, and it is not necessary, as is often the case in heavy crops, to have a man with a rake to keep the knives clear. As the knives of the mowing machine necessarily work very closely to the ground, the sections are liable to be broken or blunted by stones or other substance offering resistance; emery grindstones of suitable shape are the best sharpeners, although files are commonly used. Knife sections injured beyond temporary sharpening have to be removed, work which was tedious with the cold chisel and hammer; but during the last year or two a *section remover* has been introduced by Eddington & Co. which received the Royal Agricultural Society of England's medal, which has rendered the removal very easy. By taking advantage of the hard steel of the section, the section is made to shear through the soft metal of the rivet; thus by applying a suitably constructed hand tool to the section, with one sharp blow from the hammer the section is removed.

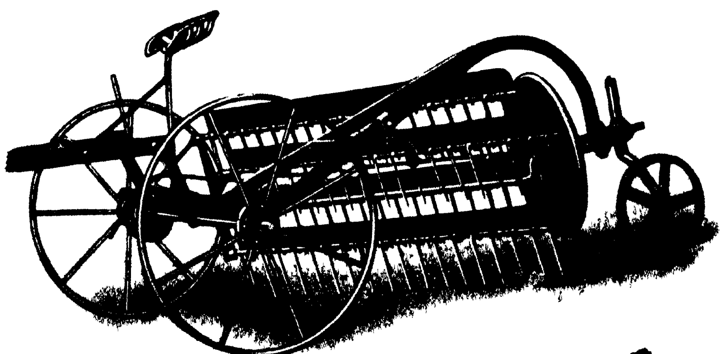
The *rotary haymaker* or *tedder*, with forward and back action, has been for many years generally used in the hayfield to ted or spread out the grass, and it greatly lessened the amount of manual labour. The forward action carried the grass under the machine, up and over, submitting it to very rough treatment, breaking the stalks and so rendering it very susceptible to rain, which soaked in prejudicially. The back action was less destructive, and did not always, when the crop was heavy, effect the work as well as was desired.

The *kicker tedder* gained much popularity within the past twenty years because of its light draught, and the gentle but effective treatment to which it submitted the grass; and so far as tedding is concerned it leaves little to be desired. The principle of tedding has, however, several objectionable features: it tends to shake out the valuable clovers and tender blades of grass, which are not caught up by the horse rake subsequently; it covers all ground and prevents the drying of the ground, therefore prolongs the drying of the grass; a crop thrown out by the tedder lies beyond the control of the farmer when rain comes, and there is no position in which it can be so thoroughly wetted and spoiled. Moreover, tedded hay is mainly dependent upon sun drying, as air cannot circulate through it freely, and undoubtedly it is highly advantageous to take every advantage of wind drying at every stage in haymaking.

The *horse rake* becomes almost essential as a collector when grass is tedded, although of course it can be got together by hand rakes, which make good work; but hand labour is expensive, and not always readily obtainable. Grass collected by the horse rake is packed and wadded very closely, and unfortunately the damper parts are collected in the wads, consequently if these are not shaken out the drier part becomes overdried whilst the wads are

HAYMAKING MACHINERY—I





3

1 "Albion" Two horse Mower 2, Martin's Side delivery Rake.
3 Blackstone's Swath Turner and Hay Collector

becoming dry enough for the next operation to be proceeded with. Still, the hay rake is valuable as a quick means of collection, especially when the grass is dry.

The *swathe turner* permits the grass to be worked without being tedded, as the butts of the swathe can be lifted or turned as much as is desired and the swathe is not broken; the quickness and small expense with which the swathe can be turned permit frequent turning and full advantage being taken of the air. It is in reality haymaking 'in the air', where undue sun baking is avoided, the colour retained, and as little as possible change in the condition of the food material secured. With the grass lying in the swathes there is always interspace, where the ground is drying, so that whenever they are turned they go on to dry ground instead of being brought into contact with moisture. Beyond this, little of the leafage and clover is shaken out. The essential principle in a swathe turner is a system of rotary blades or prongs turning helically, so that as the machine advances all the ground below the swathe is swept, the grass being lightly lifted and turned aside and over. On some machines, however, a series of prongs travelling round two heads or pulleys are employed. As a rule the machines are made to work two swathes at once, though three rows are effectively worked on some machines. The machines are made convertible, so that they can be used as collectors to work two or more rows into wind-rows; in fact, from a single swathe turner to a two-row wind-row, and on until several rows are 'put in' as a carting wind-row. It is desirable that the turner in revolving should take a broad sweep on the under side, so as to more effectually clear the swathe, and this is generally well effected.

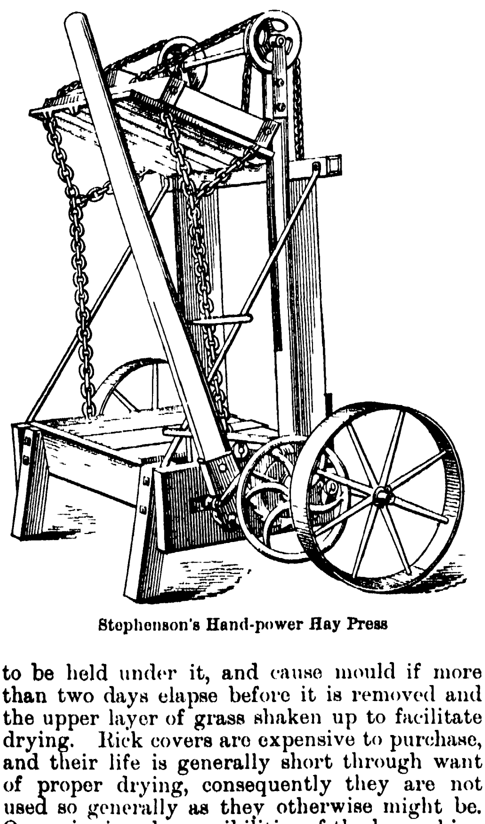
Hay collectors and *turners* embody principles contained in swathe turners, and some others peculiar to themselves. In the place of a separate turner for each row, the machines are made to collect two or more rows, and pass them out into wind-rows at the side. This is usually effected by a series of prongs carried on an endless carrier which circulates round two heads, one on either side of the machine; the frame carrying this is not, as a rule, set at right angles to the line of draught, but slightly obliquely. When the working prongs are in contact with the ground, the others are slightly raised, falling into work again as they pass downwards. Some machines work either to right or left; and Blackstone's not only does this, but the circulating motion can be stopped, and it acts as a horse rake, gathering up the grass, until it is desired to empty the load, when the tines are set into lateral motion and the hay discharged at whichever side is thought desirable. The use of this horse-rake action is chiefly serviceable when collecting rakings.

The *hay loader* is an adaptation of the ordinary straw elevator to collect and pitch the hay as it lies in the field on to carts or wagons; it is made sufficiently high for the purpose, and wide enough to embrace the width of the wind-row. It is attached at the rear of the wagon, and the wagon horse draws it with the wagon, its own travelling wheels driving the elevator. It is a valuable aid in the hayfield, but, although extensively used, it has not attained the popularity it deserves. There are two chief reasons for this: the objection of workmen to loading hay lifted by it, and want of judgment in making the wind-rows of a suitable size. The difficulty in respect to the workmen is easily overcome by fixing a simple framework to the cart or wagon to hold the load, and prevent the risk of the men falling off and injuring themselves. A very slight wooden frame held at the four corners of the wagon by uprights will effect this.

The *hay sweep* has been much improved of late, and rendered far more controllable. A century ago, and for a long while after, it was very simple in construction and but rarely used; since, however, the mowing machine has become generally used, more attention has been paid to it both by manufacturers and farmers. It is in reality a huge horse rake, with long poles as teeth, used to collect grass or clover at any period of haymaking, such as for drawing it together for making it into field cocks, or for collecting and hauling to the stack. A very considerable quantity of hay can be collected in a brief period, but owing to the great width of the sweep it is not possible to go through ordinary gateways, therefore the haystack must be made in the field; moreover, it is not suitable to pass over roads, as too much dust is swept into the hay. The ground, too, must be fairly level, though in improved sweeps fitted with an adjusting lever the difficulties of unevenness are somewhat overcome. The long tines run under the hay, which is shoved to the rear, and this continues until the sweep will hold no more. If it is desired to empty at once, the sweep is run backwards and the hay slips off; otherwise it can be drawn to a desired place, as to a stack, and there be emptied. It does not appear that the usefulness of this principle of collection has been extended to its possibilities, notwithstanding the fact that it is already a valuable implement.

The *stacker* or *stack elevator* has been in general use for a number of years. It is unfortunately an expensive machine, and generally remains in good working order for but a few years, because it is subject to decay through want of proper housing and sufficiently frequent cleaning. Also, whilst the stack is only as high as a wagon load there is not much advantage in its use; however, when the stack rises high enough to require a direct high lift it is a great labour saver, and men work more effectively. Were it not that the top of a stack can be worked as rapidly as the bottom, the economy would not be so apparent as it is; for a horse and often a boy are required to work the elevator, and the cost of these, and in hauling and setting the elevator, might be spent on labour on the stack. The fact remains that work goes on better with the aid of the elevator, and all heavy work is taken off the men; but in comparison with most mechanical aids it is somewhat dearly bought. The *horse pitchfork* or *clip-fork stacker* is becoming increasingly popular, and on hay farms where little corn has to be stacked it is a cheap and effective implement and well answers its

purpose. Various methods are employed to operate the clip-fork to make it grip a load and to release it; and with a swinging crane jib the load can be deposited well into the middle of the stack, so as to minimize the labour of placing it where required. *Rick covers.*—Where Dutch barns are not available, there is no doubt great advantage in using a rick cover on poles so as to keep the stack dry, and to allow the moisture generated by fermentation to pass freely away. A sheet without poles is better than nothing; but as it does not shoot the water so freely, the water is liable to collect in depressions and so concentrate a considerable quantity on a small area, which, soaking through, runs down deeply into the stack; also the internal moisture is liable



Stephenson's Hand-power Hay Press

to be held under it, and cause mould if more than two days elapse before it is removed and the upper layer of grass shaken up to facilitate drying. Rick covers are expensive to purchase, and their life is generally short through want of proper drying, consequently they are not used so generally as they otherwise might be. On reviewing the possibilities of the haymaking machinery mentioned above, it is easy to see how little necessary it is to be dependent upon manual labours. Two hay sweeps, with a lad and pair of horses, will bring together for a short distance as much hay as can be dealt with at the stack; or when loading with a hay loader, three hands only are required to put the hay on to the wagon for it to be carted a greater distance. Thus, in haymaking one man can cut, one lad turn with a swathe turner, and three men load, making all the hands necessary in the field in fine weather; though in the event of the prospect of rain, when it might be advisable to run the hay up into small cocks, additional hands might be required; but manual work has practically ceased to be required in the hayfield except to control machines. See also preceding art. and art. Ricklifter. [W. J. M.]

Hay Presses.—Hay presses have come into general use in recent years, as they are undoubtedly profitable to use, the hay presenting a better appearance, and requiring less room in transit or storage. For farm purposes hand-power presses are commonly used, but when preparing large quantities for export or other purposes, power presses are more suitable. In the former case the trusses as cut are compressed, while in the latter it is more usual to bale the hay. A steel body perpetual baling press, with self-feeder and automatic hinged dropper, which leaves the bale securely bound, is capable of dealing with 20 to 25 tons per day. With a horse baler a man and two boys will bale 6 to 8 tons per day. A double-speed hand-power press for compressing trusses, fitted with weighing apparatus, is a convenient form for dealing with trusses when the ordinary truss shape is desired. [W. J. M.]

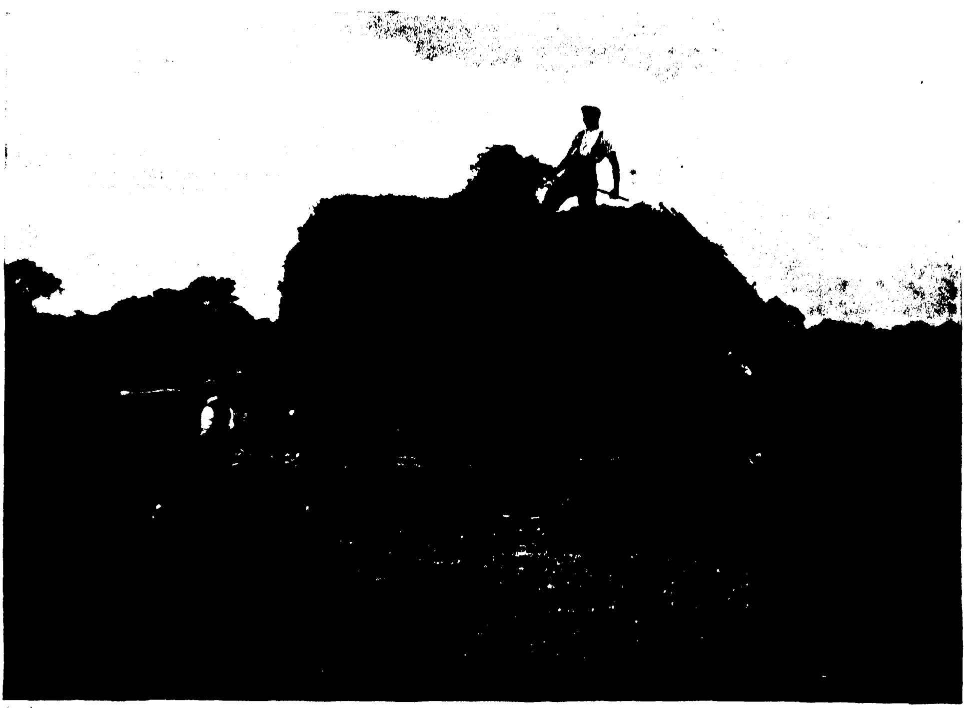
Hay Rack.—Hay racks are generally attached to the walls of stables and other feeding boxes; but portable racks for feeding hay to sheep and cattle are also used. Many horsemen object to the ordinary hay rack jutting from the wall above the horse's head, as it is liable to cause dust and dirt to get into its eyes; low racks are therefore more often used than they were. A rack is practically of any shape, and is a hay holder with open bars through which animals can eat the hay placed in it.

[W. J. M.]

Hay Rake.—Hay rakes are not used so much as they were before the swathe turner and hay collector were introduced. The hand rake is used to turn swathes, to collect grass that has been tedded or spread over the ground, and to bring it into wind-rows. The horse rake is used to collect hay at any time during the process of haymaking. The hay horse rake is usually made with a bigger bow to the sickle tine than one which is required only for corn raking, though on ordinary mixed farms one answers the purpose of both hay and corn raking. Horse rakes are made practically self-acting, as all that is necessary in modern rakes is to apply slight pressure to make the pawls engage with the ratchet wheels, when the teeth are made to rise to deliver the load, and they immediately drop automatically into work again. Heel rakes or drag rakes were used before horse rakes were used, and they were not of serviceable form before 1850, when James Hart invented the sickle tine and lever for emptying. Heel rakes are still used by some to drag behind the pitchers, but horse rakes are more suitable. By using the heel rake the field is cleared and no draggings are left, but it is quite easy to do the same with the horse rake if there is a horse available. [W. J. M.]

Hay Sheds.—Hay sheds or Dutch barns are now extensively used on the farm. They were not much used before the wet seasons at the end of the 'seventies, but the desirability of permanently securing hay and corn crops was strongly emphasized at that time, and they are

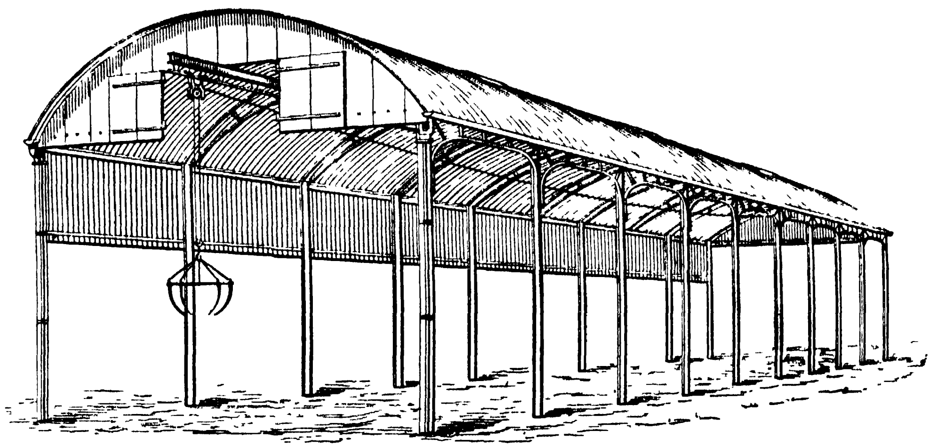
HAY LOADER IN OPERATION: THE START



(103)

HAY LOADER IN OPERATION: THE FINISH (9 minutes)

now met with in great frequency throughout the country. The development of the galvanized-iron roofing undoubtedly tended to popularize them, as the light frames needed to carry even a wide roof made it possible to erect sheds at moderate expense. No doubt the very general idea that thatching is a difficult art to acquire has also had an effect in making farmers depend more upon permanent roofing, and therefore the extension of the use of hay sheds. Hay sheds are so useful that we do not like to deprecate their use, but we do not subscribe to the idea that thatching is difficult to learn, or that it is expensive to carry out. A few instructional hints will be enough to make any reasonably intelligent man become a reliable thatcher with a little experience. The demand for hay sheds is naturally greatest in districts where rain is most frequent, and where straw for thatching is most difficult to obtain. In Ireland they have been freely availed of, especially as money was for a long time advanced on easy terms to tenants by the Board of Works, and since the formation of the Board of Agriculture, by that department. By far the greater number of the hay barns erected are roofed with galvanized-iron sheeting, but by no means all. Wood sheeting on the Moscrop principle, where the roof boards are left with ½-in. interspaces, and grooved to prevent the rainwater from getting into the spaces, are employed with considerable frequency. The roofs are light, and, with occasional painting or dressing with protective material, are durable. We have seen a light-boarded roof covered with tarred felt remain practically intact after thirty-five years' use, nothing further being done beyond occasional dressing with tar. The modern tendency, however, is to use galvanized roofs, and as these are made in standard sizes to meet all requirements their erection



Hay and Grain Shed, with Transveyor (A. & J. Main & Co., Ltd.)

is simple, and reliable results are ensured. On estates where wood is obtainable at small expense, it can be used profitably for posts or supports, in fact the whole roof frame may be made of wood; though, as most of the roofs are semicircular in shape, standard steel or iron frames are most convenient in every respect. Hay sheds are usually built with columns 14 to 18 ft. in height, and with bays 15 ft. in width, and as they offer little resistance to the wind, the construction is light in appearance and weight. With the wide experience there now has been, makers contrive roofs with all necessary strength and the least loss of space; in fact they may be fitted with transveyors to carry hay from one end of the shed to the other on a clip fork. Most commonly a single shed is used, but two or more spans are sometimes used, and there is little limit to variations in size and arrangement. The columns should be fixed in concrete, and the floor should be sufficiently raised to ensure that no drainage water gets under the hay; the eaves should be well guttered, as the sides are usually open from the roof to the ground, though lewing or shelter may be provided for part or all the depth of the sides, and in very wet, windy, or snowy districts this is a distinct advantage. Hay sheds afford shelter at every season, and are useful to protect loads of hay or other material collected in stormy weather, and of course, if not required for hay, may be used to shelter any other crops, live stock, or machinery. [W. J. M.]

Hay Stands.—Hay stands are frames on which to build haystacks to prevent moisture from the soil passing upwards into the hay to cause mould. As a rule they are not elaborately made, and consist of a plain framework of rough timber round the sides and ends, with such further logs as the size of the stack demands, to carry crosspieces to prevent the hay sinking between them. [W. J. M.]

Hay Tea is an infusion of good hay in water. To prepare it, hay is either boiled with water, or boiling water poured over the hay. Much of the soluble matter of the hay dissolves in the water, and when cold the extract is given to cattle and horses to drink. Hay tea is said to form an excellent drink to cattle, to be extremely nutritive, and to greatly promote the secretion of milk in the udders. The hay after use may be dried and used as litter. [R. A. B.]

Hazel (Corylus) is a genus of the Corylaceæ family, belonging to the nat. ord. Amentaceæ or catkin-bearers, and is very closely allied to the Carpineæ or Hornbeams. The genus Hazel is found throughout all Europe except the extreme north, and also occurs in Asia Minor and Algiers. It consists of shrubs with herbaceous-scaled buds, deciduous serrate leaves, and monœcious flowers, the male flowers being in compact cylindrical catkins with imbricated catkin scales, and the female flowers solitary or in pairs in dwarf-branch terminal scaly buds, with each flower or pair of flowers surrounded by a bell-shaped involucre; while the fruit is a solitary and usually one-seeded oval or oblong, hard-shelled nut from ¾ to 1½ in. long, partially or wholly enclosed in a leathery envelope with laciniated margin that is formed by the bracts. Our only woodland species, the Common Hazel (*C. Avellana*, see vol. v, p. 248), abundant in coppices, is a shrub which grows to about 20 ft. high, with short-stalked, roundish or obovate, pointed and doubly serrated leaves, male catkins (mostly in 2-4 at the end of the previous year's twigs), and female catkins enclosed in buds which produce a bunch of carmine-red pistils. The flowering takes place early in spring, long before the foliage flushes, and the nuts ripen and fall in autumn. Now that the market for oak bark is practically gone, Hazel is (along with Ash and Chestnut) one of the most profitable kinds of coppice in the underwoods, its long, straight shoots being specially suitable for hurdle making, barrel hoops, &c. In the south of England it often pays best if coppiced every 7 or 8 to 10 years; but it can be worked with any rotation (up to 14 or 16 years) that best suits the Ash, Oak, and Chestnut usually forming the rest of the coppice. It can bear a good deal of shade from standard trees in copsewoods, but is (like the Ash) very liable to be attacked by rabbits in winter; and in many parts of England the hazel underwood is cleared away by rabbits almost as completely as if it had been cut over—with the drawback that it is then usually killed outright, or so seriously damaged as to be ruined as an underwood crop. It has a strong reproductive power, and thrives well on most kinds of land, though a fresh or moist limy, loamy, alluvial, or humous soil suits it best. It layers or plashes well, and its side shoots can be thus utilized in filling blank spaces in coppices. Plants can easily be raised from seeds sown in spring (as autumn-sown nuts or seed are apt to be eaten by vermin), but seedlings are of far slower growth than rooted layers. The most common ornamental variety is the Purple Hazel (*C. A. atropurpurea*), with dark-red leaves, frequently planted in gardens and shrubberies. [J. N.]

Hazel—Leaf Mildew.—The under side of leaves of hazel and filbert becomes coated with a white powdery mildew (*Phyllactinia suffulta*), one of the Erysipheæ (see FUNGI, 'Ascomycetes'). It also occurs on many other trees, and may become troublesome in nurseries. If regarded necessary, as in case of filbert cultivation, a spray fluid may be used, either Bordeaux mixture (medium strength) or potassium sulphide (5 oz. in 10 gal. of water). See FUNGICIDES. [W. G. S.]

Heading-down, the operation of removing the tops of plants either for the purpose of inducing stronger growth or to prepare them for some special use. It is largely practised in nurseries, where plants are grown close together, and by cutting them back severely every year they are kept within bounds. It also induces the development of stronger growth. For example, what are termed maiden fruit trees, that is, youngsters with a single shoot, are headed down to within an inch or two of the ground in their second year. This causes them to push up a much stronger shoot to form the backbone of the prospective tree. Young trees and shrubs planted to form a fence should be headed down, that is, a portion of each plant should be cut off, so that it will push strong lateral shoots to thicken the foundation of the fence. Trees such as lilacs, pears, and apples; shrubs such as roses, rhododendrons, and laurels, may be headed down; in other words, pruned hard back when they have become leggy or too large for the position. Generally the time of year for this operation is in March or April. [W. W.]

Headlands.—Headlands are the ends of the fields or breaks, which cannot be ploughed in the ordinary way, and which have to be ploughed at right angles to the ordinary run of the furrows. Usually a headland is from 5 to 6 yd. wide to allow ample room for teams and implements to turn and set in squarely. Too narrow headlands, not allowing proper setting in, are frequently nurseries for weeds, which cause fields to become foul. Headlands are sometimes left all round the field, so that they may be ploughed all towards its outsides or all away from them. In digging a field there is no headland, because a man can dig to the extreme end. With trailing motor ploughs rather more width is required than for horses; but there is no objection in this, any more than that a headland is required for horses: if they could be done away with, it would be some advantage. But whether the headland is 5 or 8 yd. is little matter; what is important is that it is thoroughly ploughed and worked. If this is done the land will crop as well, whether ploughed north and south or east and west. We emphasize this because we have frequently heard it remarked in connection with motor ploughing that 5 yd. is the correct width for a headland and that this breadth should not be exceeded. [W. J. M.]

Heart.—The heart is a muscular organ which is located in the chest cavity, occupying the left side, and which can be felt beating under the ribs just behind the elbow in the lower animals. Its function is to propel the blood throughout the whole body, and in order to do so it must maintain a degree of strength and efficiency in proportion to the demands made upon its energy.

The average weight of the heart in the horse and ox is from 7 to 9 lb. In shape the organ is conical, and it is suspended in the thorax by means of the large bloodvessels which are attached to its base. It lies between the lungs, the base being upwards, and the apex directed down-

wards and resting on the breast bone or sternum.

The heart resembles a hollow muscle which dilates and allows the blood from the veins to flow into it, and then contracts like the closing of the human hand, pressing the blood into other vessels called arteries. It is divided into halves, the right and left, which are separated from each other by a thin muscular partition, the right side receiving the impure blood from the body and propelling it into the lungs, where it is purified, whilst the left side receives the pure blood coming from the lungs, and pumps it throughout the body. Each half is again subdivided into an upper compartment called the auricle, and a lower called the ventricle. Between the auricle and ventricle on each side are arranged important structures termed the valves, which allow the blood to flow downwards from

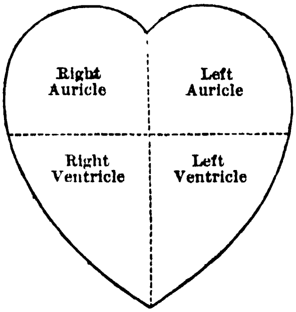


Diagram of Heart

the auricles into the ventricles, but prevent its backward flow.

As the result of disease these valves may not act completely, thus allowing a certain quantity of blood to escape backwards after each beat, and constituting a common variety of heart disease.

Excitement, exercise, and fever all increase the rapidity of the heart's action, whilst sleep, debility, and certain forms of brain disease have the opposite effect. See next art. [J. R. M'C.]

Heart, Diseases of.—Like the human subject, domestic animals are occasionally affected with heart troubles, some of which are *temporary or functional*, others *permanent or organic.* The popular idea concerning heart diseases is usually rather vague; and this is not to be wondered at, considering the varied nature of the pathological changes affecting the most important of all organs in the body. When a human being is suffering from heart trouble his medical adviser directs that he or she must abstain from all forms of excitement and severe exertion, because the heart is so easily disturbed through these influences. Although not under the control of the will, one can, by the avoidance of causes liable to disturb the heart, to a certain extent regulate its behaviour.

In the case of animals affected with heart complaints, the advantages afforded man are hardly attainable, and granting that it is possible to place the patient under such favourable conditions, its sphere of utility becomes curtailed, and utility amongst farm live stock constitutes a matter of primary importance. This is where the distinction arises between the veterinarian and the practitioner of human medicine and surgery.

The function of the heart is to pump the blood throughout the body and receive it when it comes back again (see above art.). It is a hollow muscular organ, consisting of a right and a left upper compartment (the auricles), and a right and a left lower compartment (the ventricles), with valves to regulate the current of blood passing from the upper to the lower compartments, likewise valves guarding the large bloodvessels going from the heart; but there are no valves for the bloodvessels passing into the upper compartments. The left ventricle is much thicker than the right, and this because it has to force the blood throughout the body after having been purified by the lungs. This is known as the greater or *systemic* circulation, whereas the blood in the right side goes to the lungs for purification, having been returned from the body. This is called the *pulmonary* or lesser circulation.

The heart is suspended in the middle line of the chest cavity, chiefly by means of the large bloodvessels, and it is enclosed in a bag known as the *pericardium* or *heart-sac.* It is between the fifth and sixth ribs where its impulse (shock) can be most plainly felt in the horse. Its compartments are lined by a delicate serous membrane known as the *endocardium*, and this structure is not uncommonly the seat of disease, especially in cases of rheumatism, and in swine erysipelas (see these diseases). The valves of the heart are chiefly composed of fibrous and elastic tissue, and the former tissue is particularly prone to become implicated in rheumatism. Why the poison of rheumatism should have this preference, no substantial evidence has yet been adduced, nevertheless it is a fact. Valvular disease of the heart is necessarily a most serious condition, as the adjustment of the valves may be interfered with; if so, the blood may regurgitate into the veins. Not uncommonly, rheumatism leaves its legacy in the form of warty or cauliflower-like excrescences upon the valves, or the lining of the heart. This is known as *chronic endocarditis*, which is *permanent* and *incurable.* The normal sounds produced by the beating of the heart are expressed by the words *lubb dupp.* The first sound is *due to contraction of the ventricle*, but the second one comes from the *valves*, so that when the latter are the seat of disease this sound is either blurred or lost. When animals are under a forced system of feeding, the extra nourishment not uncommonly leads to the excessive deposition of fat internally, more especially around such organs as the heart. If this progresses too far, it acts as a mechanical impediment to the beating of the heart. It is known as *fatty infiltration* (over-nutrition), in contradistinction to a diseased condition termed *fatty degeneration*, by which disease the muscular (flesh) fibres are gradually *replaced* with globules of oil or fat. When a heart is affected in this manner it becomes, as a rule, greasy to the touch, pale, thin, enlarged, and flabby. Supposing that

there is such a fatty patch on the wall of the heart, it may give way (rupture), and the blood will rush out into the heart-sac, producing sudden death.

There are no symptoms during life that will enable either the expert or the layman to recognize the existence of this disease. A complaint of somewhat frequent occurrence in cattle, especially milch cows, is inflammation of the heart-bag, or *pericarditis* (traumatic), brought on, in nine cases out of ten, through the animal swallowing a nail, hairpin, or other sharp object accidentally gaining admission into the food. Dairymaids should avoid the use of hairpins for this reason. The foreign body thus swallowed *gradually* makes its way through the wall of the stomach until it penetrates the heart-bag, and substance of the heart, perhaps, in addition, the animal meanwhile not thriving as it ought to do. Commonly it is troubled with hoven (dew-blown) immediately after taking food, so that the gaseous distention of the stomach becomes more or less *chronic.* It is surprising what a long time (months or even a year or so) cattle will go on in this manner—neither getting better nor, *apparently*, much worse.

The rate of progress is usually proportionate to the nature of the foreign body swallowed. If a very sharp object, its passage towards the heart will be quicker than a blunt-pointed object. Again, exertion has an influence over the development of the acute signs. Sometimes the slumbering defect does not show itself until the animal has been put to the bull, or some form of extra exertion. The best remedy is slaughter. The heart is occasionally implicated in tuberculosis (see TUBERCULOSIS).

Dropsy of the heart-sac usually results from the inflammation last alluded to, but it may be as an extension of a severe pleurisy.

All animals are liable to *palpitation of the heart*, which may be either *functional* or *organic.* Tumultuous beating of the heart is frequent in horses when affected with acute founder of the feet, likewise in lockjaw. In cattle, functional palpitation is often due to digestive irritation, and the beating of the heart is so violent that it may be heard some distance from the animal. It is best controlled by giving ½-oz. doses of bromide of potash, combined with 20 grains of powdered foxglove, in 1 pt. of gruel, night and morning until about half a dozen doses have been given, followed by a dose of Epsom salts and treacle. These doses are for adult horses and cattle only.

In all heart affections keep the animals as quiet as possible: give scalded oats and bran to horses and cattle; farinaceous and other soft foods to pigs, dogs, &c. The nerves supplying the heart are the pneumogastric and sympathetic, and these have quite opposite functions: the former *controls* its beating, and the latter *accelerates* it. [F. T. B.]

Heart-and-Dart Moth.—One of the night-flying moths the larvæ of which are very destructive to growing crops and garden plants. See AGROTIS and SURFACE GRUBS.

Heartwood, or **Duramen,** is that inner, older, harder, and usually darker-coloured portion of a tree which consists of inert tissue that has become highly lignified, and has at the same time become greatly constricted and condensed through the constant pressure long exerted upon it by the successive zones of younger wood annually superimposed above it. It is usually darker in colour and contains fewer nitrogenous substances than the more recently formed sapwood or *alburnum*; and it is therefore more durable, *i.e.* less easily decomposed, than these younger parts of the tree. Perfectly formed heartwood consists of woody tissue that has ceased to perform vital functions, for no sap ascends through the heartwood. As it contains much less water, protein, and starch than the sapwood, and as the walls and lumina of the woody substance are more largely impregnated and filled with colouring matter, resins, oleo-resins, gums, and mineral substances, the heartwood is usually (though not always) heavier, harder, and more durable, or less easily decomposed, than the sapwood. Hence, the greater the proportion of heartwood to sapwood in any given tree, the better and the more durable is usually its wood. As *heartwood trees* producing duramen distinctly differing in colour from the sapwood may be classed Oak, Elm, Chestnut, Robinia, Apple, Cherry, Walnut among broad-leaved trees, and Larch, Pines, Douglas Fir, Thuja, Yew, and Juniper among Conifers—whereas in Ash, Beech, Horse-chestnut, Willows, most Poplars, Pear, Spruces, and Silver Firs there is only an imperfectly marked duramen; while in Aspen, Birch, Lime, Alder, Maple and Sycamore, Plane and Hornbeam there is little or no distinctive colouring, and the sapwood undergoes but little or no real or visible change. Heartwood trees can be easily killed by being 'ringed' or 'girdled' in cutting entirely through the sapwood zone into the inert heartwood; but sapwood trees can easily survive such an operation, as the sap can still ascend in the older layers of wood unsevered by the 'girdling' process. [J. N.]

Heat.—Heat is a term applied to animals at the period of œstrum. Horsing, bulling, hogging, and rutting have the same significance. See ŒSTRUS.

Heat—Damage to Woodlands.—Heat may cause damage to woodland trees, in the form of bark-scorching or sun-burn in the case of those fringing the southern edge of woodlands. On being thus scorched, the bark and the sapwood gradually die and become dry. Soon afterwards the dead bark cracks and flakes off, and the dry sapwood is exposed to the air. The tree thus loses its natural protective covering preventing the entrance of saprophytic and parasitic fungi into the woody substance; and when rot-producing fungi then obtain entrance, the wounds may go deep into the stem or may kill the tree. This sun-burn or bark-scorching is produced by the direct action of the sun (insolation) during the height of summer, when so high a temperature is sometimes produced between the bark and the wood as to kill the cambium. In woodlands sun-burn is usually confined to hot southerly edges which have been suddenly exposed to full sunshine

by felling an adjoining crop. Park trees and those accustomed to an isolated position seldom suffer from bark-scorching, although when large branches are pruned off avenue or hedgerow timber the stem sometimes gets scorched, through the loss of the previous protection. Smooth-barked trees like Beech suffer most, then young Hornbeam, Ash, Maple and Sycamore, and Spruces and Silver Firs, while Oak, Elm, and other rough-barked trees are never scorched after their thickening bark has begun to fissure. Even large and sturdy transplants of Beech often get killed by sun-burn, unless specially protected by straw, furze, &c. Sunburnt stems along the southern edge of a wood should not on that account be cut. They will continue to grow for a long time; and even if they be cut, then it is equally probable that those behind them (thus in turn exposed) may also become sun-scorched and damaged. [J. N.]

Heath is the common name for evergreen undershrubs belonging to the genus Erica and to the nat. ord. Ericaceæ. Associated with heather, these plants grow on poor dry or wet sandy moorlands, often covering extensive areas called heaths and moors. On our native heaths two species are common: (1) Fine-leaved Heath (*Erica cinerea*), having specially fine and pointed leaves arranged in whorls of three, with clusters of smaller leaves in their axils. The flowers are drooping reddish-purple (occasionally white) bells arranged in dense, very showy racemes at the ends of the branches. (2) Cross-leaved Heath (*Erica tetralix*) has its leaves arranged in whorls of four with the edges rolled back, and the surface clothed with white short down. The flowers have more pink colour, and are clustered at the ends of the branches so as to form heads or umbels rather than racemes.

Heaths are in flower from July to September, and at this season yield much honey, which is industriously gathered by bees. Later in the year the flowers lose their colour and wither, so that now the heathlands assume quite a bedraggled appearance. [A. N. M'A.]

Heather or **Ling** (*Calluna vulgaris*) is a low straggling evergreen shrub of the heath order (Ericaceæ), seldom above 1 ft. high. The leaves are very small, not spread out, but closely overlapping, in four rows. The flowers are small, $\frac{1}{10}$ in., and the rose-coloured part is not the bell corolla as in the heaths, but the calyx, which completely hides the short corolla. Heather and heaths grow in association, and often contribute largely to the formation of peat. Heather is used for making brooms, and sometimes as bedding for cattle. Some of our native birds use the buds and young shoots as part of their food. See next art. [A. N. M'A.]

Heather Burning.—It may be doubted whether heather burning was systematically practised in Scotland before the middle of the 18th century. Burning of hillsides by design was common enough, but through old statutes and fragments of estate history one does not have a hint that 'muir-burn' was regulated on some rotation principle. The following of a rotation system in heather burning was seen to be a necessity by flockmasters if not by ardent sportsmen when the higher ranges began to be put under sheep, and that did not take place in the northern half of Scotland until after 1760. The plant which comes pre-eminently under the practice of burning is the common heather or ling (*Calluna vulgaris*) of the Ericaceæ order. The *Erica tetralix*, *E. cinerea*, and one or two other varieties are exceedingly beautiful in structure and colouring when the upland year is at its most gracious period, but it may be taken that the business, the sport, the poetry and romance of the Scottish hills are essentially entwined with the *Calluna vulgaris* or ordinary heather.

The modern practice of heather burning as pursued in Scotland is controlled by the Act passed in the reign of George III, session 1772–3, the aim of the Act being 'the more effectual Preservation of the Game in that part of Great Britain called Scotland'. The new enactment repealed or amended several game laws which had been in force up till that time. By the George III Act, any person who should 'make muir-burn' in Scotland from the 11th day of April to the 1st day of November was rendered liable to fines of £2, £5, and £10 for first, second, and third offences; or failing payment, to periods of six weeks, two months, and three months imprisonment. It was provided, however, that proprietors of high and wet muirlands could give their tenants written permission to burn the heather up to the 25th day of April; but the writing authorizing the tenants to act had to be recorded 'in the sheriff or stewart court books of the county or stewartry' within which the lands were situated.

In modern practice, permission to burn heather after the regular statutory date is seldom asked for, but on the best-managed properties an effort is made to overtake in a dry season any arrears of work. The leading questions which have been discussed by proprietors, grazing tenants, and holders of grouse shootings are— the age at which heather should be burnt; whether the burning should be undertaken by proprietor, grazing tenant, or both; the best system—taking in narrow strips, small plots, or large blocks; whether the 11th of April is really just to occupiers of high, wet, and back-lying lands; and the effect of burning on the health and vigour of sheep and grouse.

All competent observers agree that heather has different rates of growth according to the nature of the soil in which it finds sustenance. On some of the poorest lands of the Highlands, especially in the north-west, the plants are not over-aged at twenty years; on the deeper and richer soils of the southern counties of Scotland, again, the growth is at its full best in about seven years. Between those extremes there are great variations, and these should be systematically studied by proprietors and tenants. Opposite sides of a valley may be different. One side may be thin, low grade in quality, and rocky, while the other face may be deep and rich, and consequently fit to grow strong plants at a fairly rapid rate. By a peculiar decree of fate, many of the best hillsides in Scotland, so far as depth of soil is concerned, fall towards the north, and

as these have often a trickling from wreaths of snow while south-lying lands are in good condition for burning, it is argued that the former are unduly handicapped by the statute. As a matter of fact, some north-facing lands have even now an excess of old heather.

On many properties the burning is overtaken by the servants of the tenant, and under the direction of gamekeepers. Tenants frequently complain that they lose good days while waiting the convenience of the estate officials. If a hill-side had been worked into a system, the burning could be taken up practically at any time during March and early April. The oldest heather and badly frost-bitten parts could be burnt as a matter of course. In the meantime there are frequent disputes regarding what are and what are not 'the worst bits'. Every lease should define the proportion to be burnt each season. A stipulation such as a 'reasonable and sufficient extent' is of little account when disputes arise between proprietor and tenant.

Burning in strips was wont to be highly praised by many who were regarded as having full knowledge of hill land. In practice there is frequently great difficulty in giving regular effect to 'stripping'. Even with a favourable wind to keep the main line of fire along the desired course, more than the average number of hands is needed to switch out the flames at the sides. The outcome too frequently is a limited amount of work. Systematic burning of small plots is not so expensive as a rule, but it partakes, to some extent at least, of make-shift. On every hillside of considerable size there are fast-growing spots, but as a rule the system of taking a tenth, a twelfth, or a fifteenth gives most satisfaction. A great deal of hill ground is spoiled by deferred and meagre burning. The sheep and grouse crowd unduly on the small spots of one-, two-, and three-year-old heather and take the heart out of it. Bracken may then come into possession.

There is much to be said in favour of giving holders of very high and mostly north-facing grazings a practically regular extension to the 20th or 25th of April for heather burning. Little if any danger need be feared in any season from the burning of rank strong growth. Grouse nests are not to be found in such. In an abnormally 'forward' spring, special care would need to be exercised by shepherds and keepers during the burning period. In course of the third week of a very mild April, the flames should be kept from straying towards three-fourths grown heather.

All flockmasters and an overwhelming majority of sportsmen agree that systematic heather burning is of very great benefit to sheep and grouse. The burning of considerable areas has a directly sanitary effect, and it provides fresh and varied feeding ranges. The owner of a flock does not like to see his in-lamb ewes labouring through long heather while they are seeking the upper reaches of the grazing. He aims at providing an easy course for them. The game tenant, on the other hand, does not consider his interests to be fairly dealt with unless 'shelter bands' are left alongside the burnt stretches. Further, he has more or less of a liking for 'cross roads', or clear pathways along which a mother bird can lead her young to water. On such points there are no real antagonisms. In broad terms it is admitted that what is good for sheep is good for grouse. Birds are known to be more vigorous on regularly burnt moors which have a fair stocking of sheep. The question has sometimes been asked, Why not take advantage of a favourable December or January for heather burning? One objection is that the roots of the stems of the plants and ground fog are seldom dry enough in winter. Too many strong grey 'snags' might therefore be left to tear the wool off the bellies of the sheep. A more serious matter is the danger of complete extermination of young shoots by succeeding frosts. [J. CA.]

Heck, a rack for holding fodder such as hay or straw, and from which cattle feed.

Heckle, an iron comb used in dressing flax or hemp fibres. See also HACKLE.

Hedera, a genus of Araliaceæ, of which *H. Helix*, the familiar Ivy, a native of Europe, including Britain, North Africa, and West Central Asia, is the only species cultivated. This is a root climber on trees and rocks, and the leaves on the main stems are usually much more divided than are those on the smaller projecting shoots, which do not climb. The yellowish-green flowers, borne in paniculate umbels, are produced late in the year. They are not showy, but are much visited by flies and wasps in quest of honey; they give place to small black berries which ripen during the following spring. A bitter principle called hederine, and also an acid, are obtained from the plant; an ointment is made from its leaves, and these are also esteemed in rustic medicine. Ivy has an injurious effect upon trees if it is permitted to grow rampantly. It is said to make the walls of houses damp, but if kept within bounds, by keeping much of the rain from penetrating to them it has rather the contrary effect. A more just criticism is that by being permitted to grow unchecked it often hides the more delicate architectural features of historic buildings. There are few more widely useful garden plants than Ivy. In addition to its ornamental value upon buildings and walls, it will form a carpeting beneath trees where even grass will not grow, and it will quickly cover iron fences and hanging chains; moreover, it will thrive in the smokiest towns, and in any sort of soil. The old foliage should be close clipped off in April. Where this is done it is soon replaced by a fresh crop of bright-looking leaves, and the growth is made more compact. The very numerous varieties are divided into two groups: those of a climbing or trailing habit, and those of a bushlike or tree form. Cuttings of the former root readily if planted in the open ground in autumn; but it is advisable to strike the tree forms under glass in July, or to graft them on to stocks of the climbing form. The best varieties include: Trailing forms—*Algeriensis variegata*; *amurensis*; *atropurpurea*; *canariensis* (Irish Ivy, a large-leaved kind, and one of the best for general purposes);

deltoidea; and *Maderiensis variegata*. Tree forms —*arborescens*, and vars. *foliis argenteis* and *foliis aureis*; *Rægneriana*, and Silver Queen. The variation in the size of the leaves of the garden ivies, and their colour and variegation, are remarkable. A comprehensive account of these plants is given in The Ivy, an illustrated monograph by Shirley Hibberd. [W. W.]

Hedge.—A living boundary has considerable points of advantage over a wall or fence, the most prominent being that it is better looking, and that the first cost is small. There are the objections that it takes time to arrive at maturity and needs keeping in order, but these are overweighed by the fact that everyone admires a really fine hedge. For various considerations farm hedges are usually restricted to Quickthorn, but Holly, Beech, Yew, oval-leaved and variegated Privet, Box, and Laurel are all quite commonly employed in gardens. Others in less general use include Hornbeam, Lawson's Cypress, *Quercus Ilex*, Euonymus, double-flowered Gorse, *Berberis stenophylla*, and the Myrobalan or Cherry Plum; while in the warmer districts *Escallonia macrantha*, fuchsias, and some other not quite hardy plants may be used. Nor does this exhaust the list of subjects suitable for the formation of hedges; *Maclura aurantiaca*, the Osage Orange, is, for example, excellent for the purpose, and we have seen *Colutea arborescens* used with good effect. The large-fruited Blackberries form a profitable kitchen-garden hedge; where a tall one is required the Damson answers very well; and in good soil a Hessle Pear, Bramley's Seedling Apple, or Czar Plum may be planted here and there in field hedgerows with advantage. The secret of forming a good hedge is to plant young, well-rooted stock with several leads closely together in good soil, which should be kept open at the roots. Thorns are cut nearly to the ground the first year to encourage bottom growth, and in the case of all hedge plants pruning and clipping must be regularly attended to. Holly transplants best in April or September. In the selection of hedge plants, local conditions must be kept in mind; a Beech hedge can scarcely be bettered, for example, but there are many places in which this plant will not thrive. See also FENCES and HEDGEROW TIMBER. [W. W.]

Hedgehog (*Erinaceus europæus*), a common animal throughout Britain, the only British representative of the family Erinaceidæ, within the order Insectivora. Among its distinctive features, the following may be noted: the back and sides are covered with short grooved spines, which are modified hairs; on the face and under parts there is stiff, coarse fur; there is a conical snout ending in a naked tip; the tail is rudimentary (1½ in.); the skin-moving muscle—the *panniculus carnosus*—is stronger than in any other mammal, in obvious relation to the hedgehog's habit of erecting its spines and of rolling itself up in an invulnerable ball. There is a gap between the two front incisors, in the upper jaw, which are vertical and conical, the corresponding pair below slope almost horizontally forwards, the molar teeth bear sharp cusps, the dental formula is $\frac{3}{2}$ incisors, $\frac{1}{1}$ canines, $\frac{3}{2}$ premolars, and $\frac{3}{3}$ molars. The length of head and trunk is about 10 in.; the feet are plantigrade, and the short legs hardly lift the belly off the ground; there are long, curved, compressed claws not adapted for burrowing. The female has three pairs of abdominal teats, besides a pair in the axilla and another in the groin. She bears four to eight young ones in a litter about midsummer, and there is sometimes a second litter in the autumn. A litter of ten has been recorded. The period of gestation is about a month. The young are born in a nest of dried leaves and the like, such as is used for the hibernation. They are blind at birth, and have soft, flexible spines. During the day the hedgehog usually rests, at the roots of the hedge or in some hole at the foot of an old tree; it is active at night, and moves about restlessly in search of food. It has acute senses of hearing and smell. Its cry, which is not often heard, has been described as 'something between a grunt and a squeak'. The hedgehog passes the winter in what may be called very deep sleep, the functions of nutrition and excretion are in abeyance, the heart-beats and respiratory movements are extremely sluggish, and deep-seated changes affect the whole body. The miscalled 'hibernating *gland*' is a brownish mass of fat with a rich vascular supply, which occurs about the neck, armpit, and back, and is slowly absorbed during the winter. The European hedgehog extends from the Caucasus to Ireland, and as far north as 61°. The fox and the badger are among its most formidable natural enemies. As to the practical importance of hedgehogs, it should be noted first of all that they feed largely upon insects—larval and adult—and destroy many which are injurious. It is also certain that they eat slugs and snails, which is again a benefit. They have also been known to kill adders and mice, which is also to their credit. They seem to be fond of earthworms, but that is neither here nor there. On the other hand, it has to be admitted that hedgehogs have a wide range of appetite, and it seems to have been proved that they occasionally enjoy the eggs and young of game birds and poultry. On the whole, however, they do much more good than harm, and it is a pity to kill them. It may be added that the hedgehog was often roasted in days when flesh food was more of a luxury than it is at present. [J. A. T.]

Hedge Knife. See HEDGING TOOLS.

Hedge Mustard, a cruciferous weed commonly found on banks, roadsides, and waste grounds. See SISYMBRIUM.

Hedge Nettle, a plant so called from the appearance of its foliage. It is not a nettle, but belongs to the genus *Stachys* or woundwort. See NETTLE.

Hedger.—Hedgers are, or should be, specially skilled workmen, accustomed to the use of the various tools which are required for hedging and ditching—for hedging and ditching are too closely associated to be regarded otherwise than as allied arts; they must also have experience in the theory as well as practice of hedge making and preserving, for it takes careful observation and skill to make a good hedger. As a

skilled workman, he is worth more wages than an ordinary labourer; but as much of his work lies in winter he is always ensured of work. The work of planting a quickset hedge and treating it until it becomes a fence is altogether different from that of taking in hand a hedge which has been neglected for many years, where the wood may be 5 in. or more in diameter, and where there are old stubs of trees to be cleared out, and where a ditch has to be practically re-dug. Further, it is quite different from making a dead wattle fence. Moreover, different kinds of wood possess different characteristics and have to be dealt with accordingly; hence the hedger has in a way to be somewhat of a forester, at any rate so far as a knowledge of the plants he has to deal with goes; and a resident hedger should be able to rear his own plants in the nursery. When dealing with a newly planted hedge, his work is chiefly in the direction of keeping the ground clean about it, and in preserving a mulching of soil about the plants in dry weather to keep out the drought. Then, according to the growth, he has to cut the hedge back so as to make it more vigorous at the base, and year by year he has to shape it, preferably so as to form an isosceles triangle in the cross section, keeping good the guard fences so that it may not be gnawed by sheep or broken through by cattle. Or he may have a grown hedge which requires to be cut back, and his treatment will differ accordingly as it was planted in a single row or double row; he may cut down one side and leave the other as a fence until the cut side is up high enough to allow the other side to be cut. Or he may have to plash or layer it, because a fence must be maintained constantly, and he takes out the unnecessary wood, leaving enough to form the wattle. Or he may have a ragged old hedge to put into shape, with old tree stumps to remove, and here he will have to exercise much judgment as to what shall be taken out, though he will keep in all the young wood available. In work of this sort he has to use a considerable variety of tools, and be an adept in their use (see art. HEDGING TOOLS). It may be he has dead fencing to put up, it may be a 3-ft. hedge to retain sheep, or a 4 ft.-8 in. hedge to hold up cattle. He will have to sort his wood to get suitable stakes, set aside the long withies or binders to make a secure binding to finish the hedge, and having set up his stakes, work in his heavy wood at the bottom and his lighter wood at the top to prevent its being top-heavy; will turn his brushwood to the side where cattle are most likely to be troublesome, and make such a tight wattling that, though it is not so dense that wind cannot pass through it, it will keep firmly knit under the stresses it is put to. All these operations require intelligence, and this a hedger must have, as well as be able to manipulate the tools in a workman-like manner. But good hedgers are rare in many districts, consequently there are many bad hedges—many hedges that are not fences. [W. J. M.]

Hedgerow Timber was formerly, in the days when we were dependent on curved oak for shipbuilding timber, of far more importance than it now is, when trees are retained in the hedgerows far more for their ornamental effect than for the value of their timber, or for any direct or indirect benefit they bring to agriculture. Indeed, so far as arable cultivation is concerned, hedgerow timber invariably damages the field crops by overshadowing and drip to a much larger extent than can possibly be made up for by any partial benefit it may be supposed to confer in the way of shelter from wind. As Lord Kames said in his Gentleman Farmer (p. 283): 'To plant trees in the line of a hedge, or within a few feet of it, ought to be absolutely prohibited as a pernicious practice'. Throughout central and southern England it was formerly always customary for a clause to be inserted into farm leases providing for the retention by the landlord of not *fewer* than a certain fixed number of trees per mile of hedgerow; but owing to the depression in the rental value of agricultural land, this clause has now in many places been converted into a proviso that not *more* than a certain number may be retained. On grazing land an occasional oak tree in a field is useful for shade and shelter in hot summer weather; but where shelter from wind is desired for fields or stock, this is far better obtained by planting a proper wind-screen or shelter-belt than by attempting to multiply hedgerow timber, the retention of which must, by its overshadowing, spoil the hedge and interfere with its efficacy as a fence. And some kinds of hedgerow trees, more especially Ash and Elm, throw out long superficial rootstrands into the fields which rob the soil of a considerable portion of its soluble nutrient salts and therefore diminish its fertility, besides sometimes actually interfering with the work of ploughing. Standing isolated, hedgerow trees have naturally a strong tendency to run largely into branches, which means a greatly increased area of overshadowing and keeping off the sun's warmth within the radius of their shadow thrown all along the north side of the hedge. The examination of any ripening field of corn will at once show how thin, poor, and backward such part of a field always is, and how much the farming tenant loses thereby. Everything considered, the Oak is perhaps the best tree for hedgerows and fields, and especially the sessile or Durmast Oak, which is of a straighter and less branching habit of growth than the pedunculate or English Oak; and undoubtedly the worst of all is the wide-spreading, thickly foliaged Beech, beneath whose heavy shade no crop can thrive. So far as the minimum of injury to field crops is concerned, the most suitable trees for leaving in hedgerows would be quick-growing and lightly foliaged kinds like Larch and Lombardy Poplar, were it not that some of these (like Aspen and Birch) might prove very troublesome in throwing up suckers and in seeding themselves far and wide. As a matter of fact, however, the trees most frequently seen in hedgerows are Oak, Elm, and Ash, while Birch, Maple, Sycamore, Poplar, and Willow are of much less common occurrence. The evergreen conifers—the pines, spruces, and firs—although trees of an upright habit, are seldom seen in the hedgerows, as they all grow

beat in large masses. And even the Larch makes a poor appearance there, especially during its leafless winter condition. Hedgerow timber is usually grown from some strong sapling or sucker found in the hedge and selected as a standard. But a better class of tree is certainly obtained by setting stout 6 or 8 ft. transplants from the nursery, which have been frequently transplanted in the lines in order to stimulate the growth of fibrous roots. And it is well to prune them later to a height of 10 to 15 ft. to protect the hedge against overshadowing, and to lop their side branches from time to time to prevent them extending too far into the field. [J. N.]

Hedge Sparrow (*Accentor modularis*).— This common and pretty resident is *not* a 'sparrow' at all, nor even a finch, but closely related

Hedge Sparrow

to the warblers. It must not be confounded, therefore, with that ubiquitous pest the house sparrow (which see). About 5½ inches long, it can easily be recognized by the bluish throat of the adult, shading below into buff; the rust-red back marked with longitudinal black marks; and the soft narrow beak, adapted for insect food, and quite unlike the strong conical beak of finches. On the ground it moves with a shuffling hop, whence the local name 'shuffle-wing', its flight is short and direct, and it keeps to the hedges as much as possible. The breeding season begins in March, by the middle of which month the nest has been built, usually low down in a hedge, but sometimes among evergreens. This is a tolerably neat hair-lined structure, composed of various vegetable materials, together with some wool. The four to six eggs are of a beautiful and characteristic blue. Several broods are reared in a season. During summer its food consists almost entirely of insects and worms, upon which the nestlings are brought up. But in winter seeds, especially those of an oily nature, and mostly of weeds, are added to this diet. Berries and other juicy fruits are never attacked. Though not very important from the agricultural standpoint, the hedge sparrow is almost purely beneficial, and should be most rigidly protected. [J. R. A. D.]

Hedging Tools.—Hedging tools comprise a considerable number. Where a young hedge is being kept in order, a fork is required to dig about the roots, and Dutch hoes are useful to keep down weeds between the plants. A bill, or splashing hook (fagging hook, swap), is required to keep the hedge in shape. In some districts hedges are brushed, that is, trimmed into shape with a short-handled hook such as is used for cutting corn. We much prefer heavier long-handled hooks as being more expeditious, and also because they cut harder into the hedge; light short-handled hooks as a rule only brush off young tender shoots; it is owing to this that so many hedges become top-heavy, while the bottom becomes thin. When hedges have to be layered or plashed, the long-handled hook is useful to trim up the sides and to open up the hedge generally. The hedging bill is most convenient for cutting the wands ready to layer. When, however, big old hedges are dealt with, further tools are needed, and to make neat work a narrow saw is useful where a clean stroke cannot be conveniently given with a bill. It is for want of a saw that many hedgers make their first cut downwards instead of upwards, leaving a jagged cut in which water lodges and causes decay; if a rod is sawn through, it is not difficult to make a down stroke so that the wood will break off at the saw cut. When stubbing has to be done in the hedgerows, a stock axe, heavy chopping axe, spade, and shovel have to be added to the list. Where stakes have to be driven, a mall or mallet suitably made have to be added to the list. For dead hedging, a crowbar to make stake holes is needed, but the outfit for dead wattle hedging is complete with this, a bill, and a mall. A hedger requires hedging gloves and an apron of sheepskin or white leather. [W. J. M.]

Hedysarum, a genus of herbs belonging to Leguminosæ. About fifty species are known, all natives of the north temperate zone. *H. coronarium*, the French Honeysuckle, is a showy annual from 3 to 4 ft. high, with pinnate leaves and dense spikes of deep-red flowers. It is sufficiently hardy to reproduce itself every year from self sown seeds when once it is established in the border. There is a white variety of it. *H. Mackenzii*, a North American species, is a lupin-like sub-shrubby plant with erect loose racemes of rosy red flowers. They are good-natured plants, suitable for a border or the wild garden. Some of the species are used as fodder for cattle. *H. gyrans*, the Telegraph Plant, is remarkable for the spontaneous movement of its leaflets. [W. W.]

Heft. — Sheep being gregarious animals, naturally incline to go in companies or bands. This is very noticeable among mountain sheep. These, even where there are no fences, will keep together and remain on the part of the farm where they were bred; and shepherds can tell with wonderful accuracy where any particular animal can be found at almost any hour of the day, for sheep when left to themselves come downhill in the morning and go up again in the afternoon with great regularity. The word *heft* is used to denote (1) either the sheep which keep in a party on a certain section of a farm, or (2) the part of the farm on which a certain portion of the flock grazes. At times—for example when the wind is in a particular direction

—sheep may stray to a neighbouring heft, but a whistle from the shepherd makes them turn home immediately, with an almost conscience-stricken look, as if they realized they had done what they should not, or gone where they had no business. When the ewes are all gathered to the folds—say for clipping—it is extremely interesting to notice the unerring instinct with which each animal when liberated at once takes the shortest cut to the part of the farm from which it came, and it is safe to say that every one will find its way there. Even after a prolonged absence from the farm—for instance for wintering—almost all the old sheep, and not a few of the hoggs, will return without assistance to their own heft. This tendency of sheep to adhere to land where they were born and bred, makes it easier to herd an ordinary flock, but the same tendency creates the difficulty when a farm has to be stocked with new sheep. These, not knowing the ground, will wander round and round, and unless the place is very well fenced, not a few will leave it and perhaps find their way to their old home—possibly many miles distant. The process of settling sheep on a strange farm and getting them to go regularly over the different parts of it, is called 'hefting'. [W. B.]

Hefting.—This word is used in two senses, and means either the restricting of a flock of sheep to a certain portion of the hill—see HEFT —or to the unfortunate practice, sometimes adopted at cattle shows or in the auction ring, of allowing a cow to go unmilked beyond the normal period of milking, in order to give the vessel a large and swollen appearance, and hence to enhance the value of the animal for exhibition or sale purposes.

Heifer.—The young cow before bearing its first calf is called a heifer.

Helenium, a genus of North American Compositæ, characterized by a sunflower like habit, annual stems 2 to 5 ft. high, coarse green leaves, and large heads of yellow flowers The best of them is *H. autumnale*, the Sneeze-weed, which grows freely in the open border, attaining a height of 6 ft. and flowering freely in autumn. There are several varieties of it; one called *atropurpureum* has reddish-brown flower-heads. Other species worth growing are *H. Bolanderi*, *H. Hoopesii*, and *H. setigerum*. They are sturdy perennials and quite hardy. The best position for them is at the back of the herbaceous border. [W. W.]

Helianthemum (Sun or Rock Roses), ornamental hardy annual or perennial herbs or sub-shrubs (nat. ord. Cistaceæ), which flower for the most part in early summer. The numerous species are natives of the northern hemisphere, *H. vulgare* and three others being found in the British Isles. The chief purpose of the Rock Roses is for covering dry, sunny banks of indifferent soil, but they are not sufficiently conspicuous to be widely popular. The numerous and many-coloured varieties of *H. vulgare* (yellow flowers) are principally grown, while *alyssoides*, *formosum*, *halimifolium*, *polifolium*, and *umbellatum* are among the most desirable of the other species. Cuttings are easily rooted under glass. [W. W.]

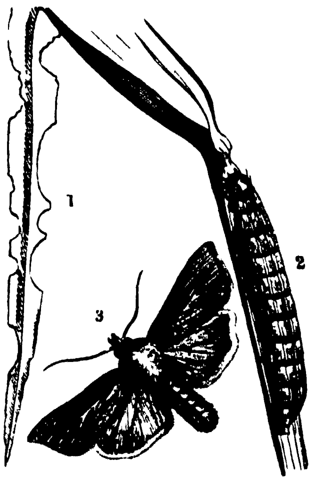
Helianthus, a genus of North American Compositæ, popularly known as sunflowers. Some of the species are annual, others have perennial rootstocks but annual stems. They are all vigorous growers, and being large-flowered and hardy, many of them are now favourite garden plants. The common Sunflower, *H. annuus*, an annual, grows to a large size under favourable conditions; we have seen it 15 ft. high, with flower-heads over 1 ft. across. In addition to its decorative value it is economically useful as a source of oil, which is obtained from its seeds and used as a foodstuff, the oil being very similar to olive oil, and, it is said, often substituted for it. An oilcake made from it is used for fattening cattle, the seeds also being employed for the same purpose. The principal source of sunflower seeds is Russia; they are also largely grown in India.

Another useful species is *H. tuberosus*, the Jerusalem Artichoke, which has been cultivated for its edible potato-like tubers since early in the 17th century. Like other perennial species, it is difficult to eradicate from soil in which it has once become established. There are several varieties of it. See art. ARTICHOKE. The best of the perennial species of Helianthus are the following: *H decapetalus*; stems 4 to 6 ft. high, freely branched, with ovate leaves, and many heads of yellow flowers about 3 in. across. The variety *multiflorus* has larger flower-heads and is a better garden plant; there is also a form with double heads, that is, the disk is composed of petaloid flowers. Another variety is known as *maximus*. *H. rigidus*, the Prairie Sunflower, has stems 4 to 5 ft. high, with alternate, hispid, dentate, ovate leaves 6 in. long, and golden-yellow flower-heads 4 in. across, the ray florets comparatively large and the disk small. There are numerous varieties of this, all of them being really handsome autumn-flowering plants, suitable either for the border or to fill a large bed in a prominent position. They are not particular as to soil. It is necessary to lift the roots every third year or so and reduce the number, otherwise the plants become weak through overcrowding. All the species ripen seeds freely, and under cultivation several hybrids have originated. The seeds should be sown in April in a little heat, and the seedlings planted outside when they are 6 in. high. See also ARTICHOKE. [W. W.]

Helichrysum, a large genus of Compositæ, about 250 species being known, and they are chiefly natives of temperate and subtropical regions, being abundant in South Africa. Some are shrubs, but the majority are herbaceous and often woolly. The species best known in gardens are annuals, several being grown largely for their flowers, which retain their shape and colour when dry, and are known as Everlasting Flowers or Immortelles. *H. bracteatum*, an Australian plant, and *H. arenarium*, a native of South Europe, are two of the most popular for this purpose. The seeds are sown early in spring under glass, or later in a sunny position outside in light soil. To get a certain supply of good flowers it is best to sow the seeds under glass in the autumn, and grow on the plants in

pots until the following May, when they may be planted outside. [W. W.]

Heliothis obsoleta (the Oat Wainscot Moth) inhabits fenny districts, the caterpillars feeding upon the leaves of reeds and oats, as shown in fig. 1. They are semicylindric, smooth, of a flesh colour, with three lines down the back, the edges green; the head is hazel, with two curved dark lines, and the first thoracic segment is dull-green, with three pale longitudinal lines; they are full grown in August, but only change to pupæ amongst dead leaves in the spring. The moth appears in June, and is chalky-ochre; the upper wings having the central nervures pale, with a whitish dot on the disc, the whole defined



Heliothis obsoleta (Oat Wainscot Moth)

1, Leaf eaten by caterpillar; 2, caterpillar; 3, moth.

by dark lines, and between them are brown streaks, with a curved row of black dots beyond the middle; under wings whitish, the hinder margin and nervures brown; base of fringe, dotted with black. [J. C.] [C. W.]

Heliotropium, a genus of about 100 species of annual or perennial herbs, rarely shrubby, belonging to the Borage family. They are widely distributed in tropical and temperate countries. They all have small flowers in terminal scorpioid cymes. Only one species has attained to any popularity as a garden plant, namely, *H. peruvianum*, the Heliotrope or Cherry Pie. This was introduced about 150 years ago, and for many years it has been cultivated in greenhouses or grown in borders out-of-doors in summer for the sake of its fragrant blue flowers. It may be grown so as to form quite a large shrub, although usually it is raised annually from rooted cuttings. There are numerous forms of it, some having the flower cymes nearly 1 ft. across. [W. W.]

Helix, the technical designation of the common snail. See SNAIL.

Hellebore. — There are different plants which, together with their rhizomes, are known as hellebore. Black hellebore is a well-known drug, and consists of the rhizome of *Helleborus niger*, the Christmas Rose (nat. ord. Ranunculaceæ). It is a bitter, acrid substance, and is poisonous. It contains two crystalline poisonous glucosides, helleborin and helleborein. It was once in considerable repute as a drug, but is now little used. Other members of the genus Helleborus which have also been used as poisonous drugs are green hellebore and fetid hellebore. All the plants of this genus are poisonous. See next article.

White hellebore is the rhizome of *Veratrum album* (nat. ord. Liliaceæ). It is a common plant in Central and South Europe, and is sometimes known as European hellebore. It contains several alkaloids and is poisonous. When ground to powder it forms a valuable insecticide, and is used to keep moths out of furs and woollens, and to destroy the insect pests of plants. In order to be effective it should be used freshly ground, as the powder loses its strength when kept. It is used both as a dry powder, which is dusted over the infected materials, and as a spray. As a dry powder it is frequently used pure, but may be mixed with lime or flour. The presence of flour is said to cause it to adhere more firmly to the foliage of plants. When used as a spray it is mixed with water in the proportion of 1 oz. to 2 or 3 gal. It destroys insects chiefly by being eaten with their food, though it is said to have some value when it merely comes in external contact with soft-bodied insects. It is less poisonous than arsenic sprays, but effective. It has the advantage that it can be applied to ripening fruits without danger, as its poisonous properties are almost destroyed after a few days' exposure to the air. It is recommended for use on gooseberry and currant bushes to destroy caterpillars. [J. H.]

Helleborus, a genus of low-growing perennial herbaceous plants of the order Ranunculaceæ. About a dozen species are known, and they all have a fleshy rootstock, palmate or pedate leathery leaves, and large flowers, which owe their attractiveness to their persistent sepals, the petals being small and tubular. The best known is *H. niger*, the Christmas Rose, which is quite hardy in the British Islands, and begins to flower in December; the flowers are white when they first open, but gradually become reddish and finally green. There are several distinct garden forms of it, the best being one called *altifolius*. This has leaves 1 ft. high and flowers 4 to 5 in. across, white, their stalks mottled with purple and green. The Black Hellebore roots of commerce, obtained from this plant in Germany, are used medicinally. Other good garden hellebores are *H. abchasicus*, flowers dull-purple, 2 in. across; *H. atrorubens*, flowers dark-purple, 3 in.; *H. colchicus*, flowers bright-purple, and borne three to six on a stem; *H. orientalis*, flowers large, rose-red. These several species have been hybridized, and from them a useful race of decorative, hardy, spring-flowering herbaceous plants have been obtained. They are all first-rate plants for the border, wild garden, or on a sloping bank by the side of water. At Kew there is a collection of them established among hardy ferns in an open wood, and they are most

effective from December until well into spring. They grow in ordinary garden soil, but they are most satisfactory where the soil is a deep loam of a clayey character. They are propagated by division of the rootstock, which should be done in August or September, or from seeds sown under glass, the seedlings to be planted in a border until they are fit to place in permanent positions, which will be when they are about three years old. Two species, *H. viridis*, flowers green, produced in March; and *H. fœtidus*, the Stinking Hellebore, flowers drooping, green and purple, are natives of this country. [W. W.]

Hemerobiidæ, a family of Neuropterous insects, including the 'lace-wing' flies or 'golden-eyes', whose larvæ are extremely useful in destroying green-fly. The common Lace-wing Fly is *Chrysopa perla*, a delicate blue-green insect often to be seen where aphidæ are plentiful, and its curious stalked eggs might be taken for a species of mould on the twigs of the infested plant. Many of the smaller lace-wing flies belong to the genus Hemerobius. The larvæ crawl actively over the leaves and attack the green-fly, sucking their juices. Many of them have a habit of covering themselves with the empty skins of their victims. See also CHRYSOPA. [C. W.]

Hemerocallis, a small genus of Liliaceæ, popularly known as Day Lilies. They have a fleshy perennial rootstock, from which spring annually distichous, curved, grassy, green leaves and numerous tall branching scapes, bearing large lily-like flowers coloured yellow or fulvous. The cultivated species are natives of Japan, and are therefore hardy in the warmer parts of the British Islands. They grow freely and flower copiously when planted in a sunny position in ordinary garden soil. They also grow well on the side of a pond or stream. The best of them are *H. aurantiaca*, *H. Dumortieri*, *H. flava*, *H. fulva*, *H. Middendorfii*, and *H. minor*. Several hybrids have been raised in English gardens. [W. W.]

Hemlock (*Conium maculatum*) is a biennial umbelliferous plant, common in fields, hedgerows, and waste places, where it flowers in June and July, and ripens its fruit early in August. By the end of the latter month it has usually disappeared. The stem is hollow, dull-green, or covered with a slight bloom, even, taper, spotted more or less with brownish purple; in rich soil, or when allowed to grow without injury, it reaches the height of 5 or 6 ft. The leaves are bright-green, very large, repeatedly compound, with closely set pinnatifid leaflets, which are free from hairs; their stalks sheathe at the base, but are not very much dilated. The flowers grow in compound white close umbels, surrounded with both general and partial involucres. They are succeeded by small oval fruits, vulgarly called seeds, which are marked with ten knotted ribs (as is shown in a magnified figure at the right-hand corner of the annexed woodcut). These fruits are desti-

Hemlock (*Conium maculatum*)

tute of the oil receptacles, or vittæ, to which other umbelliferous grains owe their fragrance.

Hemlock is a very poisonous plant, containing as it does the poisonous alkaloid *conine*. From other umbelliferous plants it is distinguished (1) by its habitat, fields, not marshes and ditches; (2) by the entire absence of hair; (3) by the spotted stem; (4) by the bruised leaves emitting the mousy odour of conine; and (5) by the peculiarly knotted ribbed fruit, destitute of all aroma. [J. L.] [A. N. M'A.]